E ENGINEERING CONSTRUCTION WEEKLY

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JUN 22 1937

Engineering NEWS-RECORD

June 17, 1937

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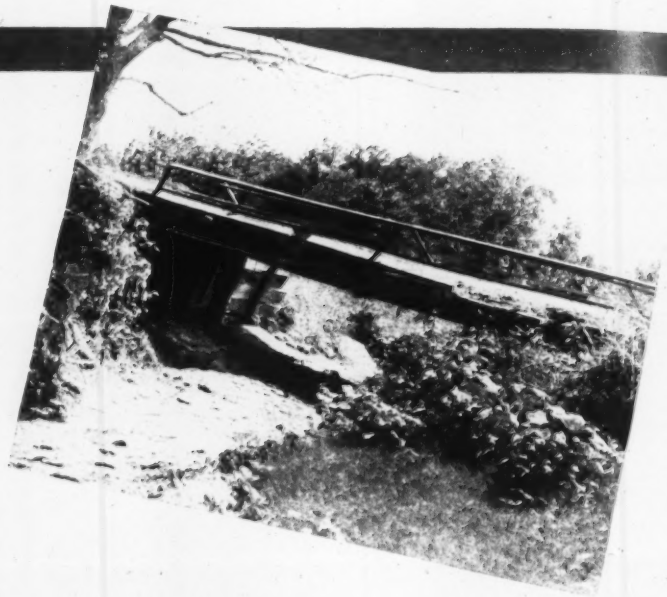

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ENR—6-17-37

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Where Spades Are Spades

EVEN CASUAL PERUSAL of the advertising in any issue of this journal reveals one reason why advertising in the technical or industrial paper is so acceptable to the reader and, therefore, so valuable to the advertiser.

It is the very direct and specific appeal that can be made by the manufacturer to the special needs and interests of his prospective customers. Although some advertisers still miss this point, most of them now do their best to talk straight to each particular reader group in its own language. Thus they are able to get away from the abstract terms that handicap so much general advertising and get right down to calling a spade a spade when they are talking to a gardener. In these days of keen competition for reader interest that is just the difference between wasteful and efficient advertising.

A pipe manufacturer, for example, illustrates a specific installation and relates the qualities of his product to the exacting requirements of that particular job. A truck manufacturer features the capacity of his vehicles to "withstand the abuse of continuous hard service under rough hauling conditions" such as their readers readily recognize as their own. A shovel manufacturer shows exactly why his equipment gives "faster, smoother operation with higher output and lower maintenance costs" to the construction man. A manufacturer of lubricants talks turkey about the constructor's ability to operate his diesel engines "ten times longer between shutdowns, without stuck piston rings or heavy wear on cylinder liners."

A compressor manufacturer talks specifically about "less space requirements, no heavy foundations and lower installation costs", all items of special interest to the construction engineer. A maker of rubber hose cites a specific job on which he "makes a tough life easier" for the contractor, who knows just how tough his life can be. An engine manufacturer ties up savings in power costs with putting money into the contractor's pockets and "giving him an advantage in bidding for contracts."

THESE ARE BUT A FEW EXAMPLES selected from many. Space is not here available to show how the advertisers amplify their appeals and offer their services as well as their products to meet the specific needs of the civil engineer and the constructor. Here it is intended merely to show how naturally and easily the man with something to sell to these particular users can talk to them directly in terms of their special interests.

During the last fifty years or more the American industrial-journal has raised itself from feeble beginnings to its present status as an indispensable tool of the forward-looking managers and operators of industry. This it has done, first and foremost, by giving them competent and trustworthy editorial service, directed straight to their technical and business requirements. But scarcely second in importance has been the parallel development by advertisers and their agencies of an equally practical and trustworthy body of advertising, directed toward their special needs in materials and plant.

MORE AND MORE the advertisers have come to appreciate the opportunity offered by the technical journal to get their advertising down from the blue sky of abstract claims into the more concrete terms that have practical appeal to their prospective customers.

In such a medium, advertising has a chance to work most efficiently in the interest of both seller and buyer. It does not need to affect a garb and a jargon so nondescript and dilute that it can get by in the shop, office, field, club, ballroom or at the family fireside. Business paper advertising, well done, is efficient advertising. It can get right into its business clothes and talk in straightforward business terms because it is talking to business men alone in a setting of their business interests.

And the ability to do just that must be the very essence of advertising that would justify itself by being equally valuable to the producer and his customers.

Willard Chevalier

·ENGINEERING NEWS-RECORD·

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TABLE OF CONTENTS—See Page 21

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This Wire is Just One of the Many Received from Enthusiastic Users of Rex Moto-Mixers and Agitators

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THE GENERAL SAND STONE CORPN. 950A MAR 3

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

If you are interested in lowering concrete handling costs or in getting your share from the rapidly rising market for ready-mixed concrete, you want this book. "Rex Moto-Mixers and Agitators" tells all about the modern Rex way to higher profits. Send for it today.

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REX

THE UP-TO-DATE METHOD OF HANDLING CONCRETE

MOTO-MIXERS

CHAIN BELT COMPANY of Milwaukee

·ENGINEERING NEWS-RECORD·

McGRAW-HILL PUBLISHING COMPANY, INC.

Editorial and Executive Offices: 330 West 42nd Street, New York · Publication Office: 99-129 North Broadway, Albany, N. Y.

F. E. SCHMITT, *Editor* WILLARD CHEVALIER, *Vice-President*

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VOL. 118 *JUNE 17, 1937* No. 24

THIS WEEK AND NEXT

The first tube of a second vehicle tunnel under the Hudson River at New York is nearing completion; construction of the second tube has started. The leading article in this issue tells of the new tunnel and its relation to other traffic arteries. Subsequent articles will describe the construction in detail.

Looking far into the future of highway needs, Frank T. Sheets lays down the outline of a master plan for major highways that must be worked for if we are to keep pace with growing needs.

Interesting alternatives are presented to the city of San Diego as to the manner in which it will bring in an added supply of water from the Colorado River. A report of a board of engineers favoring one route is now before the city for consideration.

American engineers are cooperating in the bridge building program for the Inter-American highway. In this issue is described the third of three major bridges to be built recently on that work, each of a different type.

North Carolina highway engineers are experimenting with bituminous stabilization of fine soils that cannot be replaced economically. Encouraging results have been obtained by two methods of treatment applied to short sections of highway.

Efforts to develop economical methods for building schools that will be safe against destruction by earthquake are resulting in new methods of framing such structures. One type is described in this issue.

Next week's issue will contain a staff survey of wage and labor condition throughout the construction industry based on interviews with contractors in many large cities.

		Page
The Week's Events		891
Reader Comment		896
Editorials		898
Pictures in the News		900
New Road under the Hudson *(Tunnels, Highways)*		901
Rubber Expansion Joints in Blower Lines *(Sewage disposal, Piping)*		907
Additional Water Supply for San Diego *(Water supply, Colorado River Aqueduct, All-American Canal)*		908
A Master Plan for Highways *(Highways, Regional Planning)*	FRANK T. SHEETS	909
Self-Anchored Eyebar Cable Bridge *(Bridge construction, Bridge architecture)*	C. B. McCULLOUGH and RAYMOND ARCHIBALD	912
Curves Inventoried in Route *(Highway Maintenance, Alignment, Surveys)*	J. M. DeBARDELEBEN	914
Firming Fine Soil with Tar *(Highway construction, Soil Binders, Stabilization)*	T. V. FAHNESTOCK	915
Earthquake Resistant School Building *(Concrete, Flat slabs)*	HAROLD B. HAMMILL	918
Current Sewage Disposal Notes		920
Field and Office Notes		922
The Week's Events (continued)		924
Unit Prices		926
New Aids to the Constructor	*Adv. page*	25
Construction Reports	*Adv. page*	43

THE COVER PICTURE is of workmen removing unsound rock from the canyon walls at Parker dam on the Colorado River

KOEHRING 5/8 SHOVEL

This modern, high speed 5/8 Yard Shovel has established highly favorable records in all types of excavating jobs, grading projects, sand and gravel pits, quarry stripping and everywhere a shovel is used. Light weight for speed — high strength steels for durability — make this machine an outstanding, high production excavator.

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THE WEEK'S EVENTS

Local Contributions to Relief Work

Senate Appropriations Committee recommends $1,500,000,000 with 40 per cent local contribution

The Senate Appropriations Committee has reported to the Senate a relief bill containing the full $1,500,000,000 asked by the Administration but containing a provision that no non-federal work relief project shall be undertaken unless the local sponsors provide at least 40 per cent of the cost. This compares with a present contribution by sponsors of 13 to 17 per cent on WPA projects.

Exceptions made

The rigor of this requirement was somewhat softened by a provision that "in any case in which the applicant on any such non-federal project certifies in writing that it is unable to supply such 40 per cent, the applicant may in lieu thereof supply such amount as the President, upon the basis of an investigation made by him with respect to the taxpaying capacity and credit of the applicant, determines to be the maximum amount possible for such applicant to supply." It is also provided that the President shall report to Congress on Jan. 1, 1938 and again on July 1, 1938, a list of all cases in which less than 40 per cent of the cost was furnished by the applicant.

Reduction attempt fails

This amendment to the bill was proposed by Senator Byrnes of South Carolina. Senator Byrnes' attempt to reduce the amount of the appropriation to $1,000,000,000 was defeated in committee.

The relief appropriation bill as passed in the House June 1 carried an unrestricted appropriation of $1,500,000,000. This result was only achieved after strong efforts had been made to incorporate amendments earmarking $500,000,000 for flood control, water conservation, highways and grade crossing elimination. It was twice necessary to adjourn the House to avoid an Administration defeat on the measure.

House Committee Finds for Florida Canal

The House Rivers and Harbors Committee on June 8 recommended completion of the Florida Canal in accordance with the recent report of Major-General Markham, chief of engineers, (*E.N.R.* April 15, 1937 p. 568). The report characterizes the canal as a project of unusual merit which would benefit a larger part of the country and its population in almost any other public works project.

A minority of the committee dissented from the report, holding that the canal is not justified from either an economic or an engineering standpoint and that the financial state of the treasury did not permit present large expenditures.

• • •

Ambrose Swasey Dies

Ambrose Swasey, designer and builder of precision machine tools and telescopes, who endowed the Engineering Foundation with a gift of $750,000, died at his home at Exter, N. H., on June 15, at the age of 90. Probably his most notable contribution to present-day industrial progress was the development of machine tools of such accuracy that they could produce parts which, when assembled into machines, would be interchangeable. Mr. Swasey was the recipient of the John Fritz medal.

MAJOR NEWS

	Page
A.W.W.A. Convention	890
Relief Bill	890
Wage Standards Bill	890
War Department Appropriations	892
Kansas Road Jobs Change	892
Norris Basins TVA Bill	893
California Bridge Collapse	894
Harrison Eddy Dies	895

Hearings Continue on Wage Bill

Black Defends disputed section 5 of the Black-Connery bill and manufacturers attack bill

At a hearing on the Black-Connery labor standards bill, Senator Black defended the much disputed Section 5 against which both labor and employer groups have protested (*ENR*, June 10, 1937, p. 856). This section provides that when the proposed labor standards board suspects inadequacies of collective bargaining, the board may step in, investigate, and issue orders for minimum wages which cannot be greater than $1200 per year, or than 80 cents per hour.

Senator Black said that the court had held that the compensation for labor must be based on fair actual value of the work at the time and place where it is performed. Therefore, a flat minimum wage unsupplemented by authority which could make variations on such a basis would, he felt, almost certainly be nullified by the Supreme Court. The bill as it now stands is modeled on the New York minimum wage law which the court has upheld.

Manufacturers oppose

At a later hearing, James A. Emery, general counsel for the National Association of Manufacturers, asked that action be delayed for further investigation. He proposed that the child labor provision be taken out of the bill and incorporated in a separate bill prohibiting the interstate transport of goods produced in violation of state child labor laws.

Holding that too much authority was vested in the proposed Labor Standards Board, Mr. Emery said that the measure as written was unconstitutional, and went beyond the commerce power of Congress. He held it further unconstitutional on the ground of a "vague" delegation of authority.

Mr. Emery also asked that if the provision forbidding hiring of strike-breakers and labor espionage were incorporated in the bill, restrictions on labor unions also be included.

Water Works Convention

Twelve hundred gather in Buffalo for A.W.W.A. convention featured by diversified technical program

Administrative and legal phases of water conservation as well as a diversified program of technical subjects were featured at the 57th annual convention of the American Water Works Association in Buffalo on June 7 to 10. About 1200 members were registered at the four-day meeting which also included inspection trips to nearby industrial plants and an excursion to Niagara Falls. The display of equipment exhibited by 80 manufacturers provided an unusual opportunity to study at first hand many new products now available.

One of the highlights on the program of about 50 papers was a review of administrative methods of approach to water conservation and pollution control. General agreement existed in regard to the need for closer cooperation between federal and state agencies. The details of organization in realizing this objective, however, were held to be too vague and to require careful study before plans are drafted.

Gastro-enteric epidemics

Also featured was a panel discussion on the relation of public water supplies to gastro-enteric epidemics. Observations were reported in which water supplies were under suspicion but no direct evidence could be found to indicate that regularly identified pollution organisms were the causative agent. Some cases of dysentery outbreaks were correlated with decomposition of algae and also crenothrix growth. Two schools of thought emerged from the discussion, one group holding that present standard methods were not sensitive enough for making specific analytical examinations, and the other that present methods were entirely adequate but too frequently they were carelessly applied.

A symposium on water softening methods and a round table discussion of methods of safeguarding supply systems during major catastrophes such as floods, conflagations, and earthquakes were of considerable interest to designers and operators of water plants.

Transite pipe

Considerable controversy was raised in connection with the progress report of the committee on transite pipe. This report quoted general conclusions published by the Underwriters Laboratories, Inc., of the National Board of Fire Underwriters, but did not include detailed information concerning the comparative physical properties of cast iron and transite pipe. The association voted that this additional data be published in an early issue of the A.W.W.A. Journal.

EUGENE DUGGER
New president of the A.W.W.A.

Officers installed for the coming year were: President, Eugene Dugger; treasurer, William W. Brush.

The Water Works Manufacturers Association chose Clinton Inglee, National Water Main Cleaning Co., for president during the coming year. H. W. Ford of Pittsburgh-Des Moines Steel Co., was selected as vice-president; Edgar Buttenheim, American City Magazine, and John A. Kienle, Mathieson Alkali Co., were selected as treasurer and secretary, respectively.

Complete details of the convention will be published in next week's issue of Engineering News-Record.

• • •

Road Convention and Show to be Held in Cleveland

The American Road Builders Association has announced its decision to hold its 1938 convention and road show in Cleveland on Jan. 16, 1938. It is expected that about 250,000 sq. ft. of floor space at Public Hall will be used for the show.

Engineers Union Accuses Structural Firm

Charges were filed with the National Labor Relations Board against the Harris Structural Steel Co. by the Federation of Architects, Engineers, Chemists and Technicians, New York City, a CIO organization, claiming violation of the Wagner labor act by the Harris Co.

The union asserted that they had received authorization from a majority of the draftsmen at the Harris Co. to negotiate for them as their collective bargaining agent and that when this fact was made known to the company a campaign of intimidation and anti-union activities was carried on. These activities were alleged to include the dismissal of employees, the fostering of a company union, threats that the company would close its office and move to another city to avoid union recognition. It was also charged that the union representative, who had been in the employ of the company for about 12 years, was arbitrarily dismissed by the steel company.

Simultaneously with the filing of the charges, the union moved to put the Harris Structural Steel Co. on the unfair list of the Board of Education of the city of New York. This action would disqualify the company from performing contract work on schools in the city under the board's policy of not dealing with violators of the Wagner Act.

• • •

Abel Wolman to Teach at Johns Hopkins

Dr. Abel Wolman, chief engineer of the Maryland State Health Department, has been appointed professor of sanitary engineering at Johns Hopkins University in Baltimore, the appointment to become effective September 1 at the beginning of the academic year.

Dr. Wolman holds numerous engineering posts, some of which he plans to relinquish to give his time to his work at Hopkins. He was a member of the first graduating class of the engineering school at Hopkins, 25 years ago, and when the school celebrated its anniversary recently, he was awarded the honorary degree of doctor of engineering.

In addition to his position as chief engineer of the Maryland State Health Department, he is PWA director for Maryland and Delaware, chairman of the water resources committee of the National Resources Committee, chairman of the Maryland State Planning Commission, chairman of the Maryland State Water Resources Commission and a member of the new Maryland Bridge Supervisory Committee

THE CURRENT TREND

This week's news of contract volume and construction cost factors

East Bests West in Volume

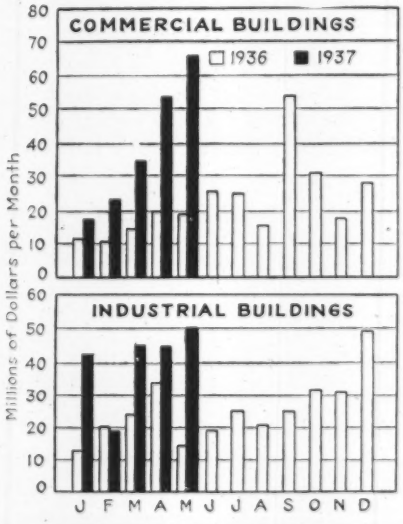
Contracts in Middle Atlantic States spurt far ahead of last year while rest of country barely keeps pace

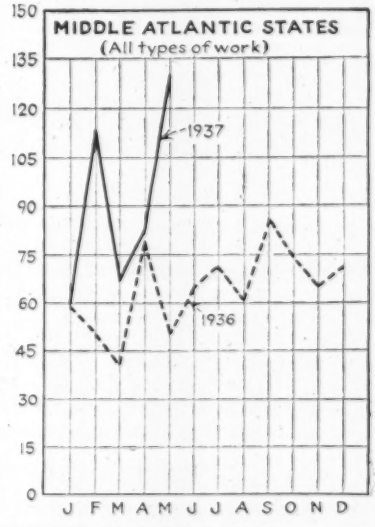
Construction is ahead of last year, but only in the Middle Atlantic States—New York, Pennsylvania, New Jersey, Delaware, Maryland and the District of Columbia—is it substantially ahead. In all other sections it is barely keeping pace with 1936.

The reason for this geographical unbalance is not hard to find. For it is in the eastern seaboard states that the bulk of commercial and industrial rebuilding is taking place. Since these classifications of work are leading the present parade, in which such public works as waterworks, sewerage, streets and roads (upon which other sections of the country depend) are bringing up the rear, the unbalance is inevitable.

The accompanying charts graphically portray the cause and its effect. The May totals for both commercial and industrial building contracts represent the highest monthly figures recorded in the last five years. And of the $65,555,000 of contracts for commercial buildings, $53,965,000 or 82 per cent was in the Middle Atlantic section while, for industrial buildings, Middle Atlantic contracts at $28,969,000 represent nearly 60 per cent of the $50,069,000 total.

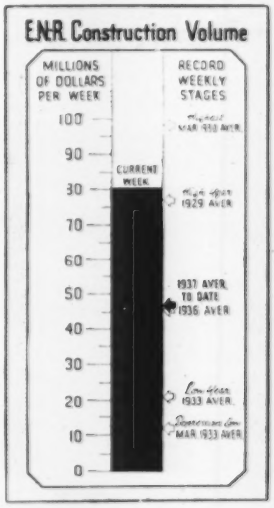
Indications are that the east will continue to lead the west—and the south—until federal money for flood control reservoirs, for one thing, comes through to swell their totals.





THIS WEEK'S LARGE CONTRACTS

Steam power plant—Pennsylvania Power Co., West Pittsburgh, Pa.				$2,800,000
Electric power plant—Narragansett Electric Co., Providence, R. I.				2,000,000
Keystone Dam, Keystone, Nebr.				2,736,000
Hydro plant—Idaho Power Co., Hagerman, Id.				2,400,000
Factory—Chevrolet Motor Co., Tonawanda, N. Y.				5,000,000
Residences—Beverly Lake Park, Inc., New Rochelle, N. Y.				15,000,000
Armory—St. Louis, Mo.				918,000
Substructure, Mississippi River Bridge—Baton Rouge, La.				2,421,000
Highways—Mississippi	881,000	West Virginia	557,000	Oklahoma 746,000
Montana	593,000	North Dakota	533,000	Ohio 1,274,000



THIS WEEK'S FIGURES

CONTRACTS
(Thousands of Dollars)

	Week Ending June 18 1936	June 10 1937	June 17 1937
Federal	$9,788	$5,052	$4,049
State&Municipal	36,215	20,676	28,333
Total public	$46,003	$25,728	$32,382
Total private	11,618	17,155	47,998
TOTALS	$57,621	$42,883	$80,380

1937 (24 weeks) $1,129,898
1936 (25 weeks) $1,074,010

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1937	Week June 17	Cumulative
NON-FEDERAL WORK	$7,965	$588,851
State & mun. bonds	7,438	250,451
Corporate securities	527	287,612
PWA loans and grants	....	40,856
RFC loans	....	29,932
FEDERAL WORK	....	.....
TOTAL ALL WORK	$7,965	

1937 (24 weeks) $588,851
1936 (25 weeks) $438,968

INDEX NUMBERS

ENR COST	1913 = 100	1936 = 100	ENR Volume	1913 = 100	1926 = 100
June, 1937	237.35	114.09	May, 1937	213	94
May, 1937	232.65	111.85	Apr., 1937	161	71
June, 1936	204.60	98.35	May, 1936	149	65
1936 (Av.)	206.46	99.24	1936 (Av.)	185	81
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50

At $80,380,000, contracts awarded reached the highest weekly total since Jan. 9, 1936. This is an 87 per cent gain over last week. Practically all classifications of work participated in the rise, commercial buildings setting a five-year record, industrial buildings reaching the second highest figure of the year and highways recording the highest total since Aug. 20, 1936. The volume chart above shows the current week above the 1929 average.

War Department Bill Passed by House

Bill carries $53,000,000 for flood control $90,000,000 for river and harbor construction

Appropriations for flood control and regular river-and-harbor improvement work of the Corps of Engineers during the fiscal year beginning July 1, 1937 were contained in an omnibus bill for non-military activities of the U. S. Army passed by the House June 15.

Amount approved for flood control is $53,416,300. Rivers and harbors get $37,177,899 for maintenance of existing facilities and $90,822,101 for the continuation of work now under way and inauguration of new projects.

Preliminary hearings on the bill brought out the fact that Congress has already authorized river and harbor improvement projects aggregating $349,175,950 and flood control work totalling $272,000,000 in the lower Mississippi Valley and $320,000,000 in other sections of the country. In the latter classification alone, plans have been prepared and assurance of local cooperation received for projects and parts of projects aggregating $150,000,000, and it will be necessary to distribute the money provided this year in accordance with a priority list based upon urgency of need for protection and willingness to comply with requirements for local contributions.

The appropriation for flood control, as the bill passed the House, is broken down as follows:

Lower Mississippi River	$22,500,000
Sacramento River	814,500
Other projects	30,000,000
Emergency fund	100,000

The tentative priority list presented to the committee for distribution of the $30,000,000 item for "other projects" is as follows:

Merrimack River basin, reservoirs	$1,200,000
Connecticut River basin reservoirs	1,500,000
Reservoirs and channel enlargements, N. Y., Pa.	1,681,000
Red River basin, levees and channel improvements	400,000
Arkansas River basin, Conchas Reservoir	5,000,000
Arkansas River basin, other reservoirs and levees	3,000,000
White River basin, levees	750,000
Upper Miss. and Illinois River and tribs., levees	1,000,000
Monongahela and Allegheny basins, reservoirs	5,000,000
Wabash River	919,000
Los Angeles and San Gabriel Rivers	6,500,000
Columbia River basin	1,000,000
Willamette River	250,000
Puyallup River, reservoir	800,000
Surveys	1,000,000

Many of the projects listed will not be completed during the year, but will require additional appropriations in the future. The list is merely tentative, as it has not been officially approved by the President, and additional authorizations now pending for the Ohio valley may be added.

Of the $90,822,101 recommended for new construction on rivers and harbors, all but about $3,000,000 is earmarked for the continuation of work already under way. The larger items in the list are:

Fort Peck	$8,706,000
Bonneville	5,000,000
Ohio and Kanawha River works, inc. Tygart Dam	4,000,000
Illinois River works to compensate for reduced diversion from the Great Lakes.	3,000,000

Testimony before the committee also brought out the fact that relief labor, to be paid by the WPA, will be used to supplement the direct appropriation for flood control. By this means it is hoped to put through a program considerably larger than could be expected from the amount carried in the bill.

• • •

Trans-Pennsylvania Road Approved by Legislature

The Pennsylvania legislature has passed and the Governor has signed a bill providing for the construction of a $60,000,000 toll road between Carlisle, Pa. and Pittsburgh, utilizing the right of way and tunnels of the old South Penn Railway.

The bill sets up a Pennsylvania Turnpike Commission which will be empowered to issue revenue bonds to meet the cost of the highway. When the bonds are retired from tolls, the highway will become a free road.

The South Penn Railroad was an abortive Vanderbilt project. The right of way was partly constructed in the 1880's but tracks were never laid. At that time seven miles of tunnels were constructed. All of these tunnels have been holed through, but some of them have not been lined and some were never brought to full diameter. Those which were finished were built to carry a two-track railway.

The decision to build the road comes after a two-year study by the South Penn Highway Commission, appointed in 1935. A survey was made by the WPA in cooperation with the highway department and the CCC. As a result of this survey, a report to the general assembly recommended that the road be undertaken, and the legislation was put through with administration support.

The main purpose of the road is to avoid the route through the Allegheny Mountains which is unsafe in bad weather. The proposed road will have no grade crossings and of its 164 miles, 140 will be on tangent and carry four-lane traffic.

Wholesale Changes In Kansas Highway Jobs

Engineering personnel hit by change in political administration of state as most top men resign

The Kansas highway department, long free of political dominance or activity, so far as its engineering personnel is concerned, is undergoing extensive reorganization at the hands of the new Democratic administration. No official reasons for the changes which have come about through so-called resignations have been given. The resignation and the appointment made to fill the coveted positions follow:

H. D. Barnes, chief engineer, has been replaced by A. B. Nuss, formerly chief engineer of WPA for Kansas. Mr. Barnes has accepted a position with the U. S. Bureau of Public Roads in Topeka, analyzing data from the planning survey.

I. E. Taylor, engineer of maintenance, resigned April 1 to enter the service of George Bennet, contractor, and his position has been taken by L. L. Marsh, formerly assistant engineer of maintenance.

F. T. Bonebrake, engineer in charge of purchasing, has been replaced by Mr. Tanahill, formerly of the WPA headquarters in Topeka.

O. J. Eidmann, engineer of design, has resigned to enter the consulting engineering business, and his position has been filled by R. B. Wills, formerly in charge of the planning survey in the Kansas highway department.

Harold Allen's position as engineer of materials has been filled by his former assistant, R. D. Finney. Mr. Allen has accepted a position in the soils department of the division of tests of the Bureau of Public Roads.

W. L. Dyatt, office engineer, has been replaced by Thomas E. Burton, formerly division engineer at Topeka. Mr. Dyatt has accepted a position in Topeka with the Connecticut Mutual Life Insurance Co.

W. K. Dinklage, formerly division construction engineer, has been promoted to division engineer at Topeka, and his place filled by R. G. Porter, formerly a resident engineer.

Rollin J. Smith, office road engineer, has been replaced by L. H. Vincent, his assistant.

In the division offices J. E. Irwin has resigned at Norton and his place filled by L. G. Morphy, formerly a resident engineer. J. A. Roby at Garden City has been succeeded by W. S. McDaniel, formerly division engineer at Hutchinson. Mr. McDaniel's office is filled by W. C. Myers, a PWA official.

Norris Water Bill Is Power Measure

Washington correspondence

Although presented as a water conservation measure, the Norris bill setting up seven regional authorities is regarded primarily as a power measure. While the bill seems to have the blessing of Secretary Ickes, it is not expected to receive administration support. In effect it would set up seven Interior departments, seven departments of agriculture and duplicate in the seven regions many activities conducted in Washington. Its objective, apparently, is to develop a constitutional basis for the government to get into the power business.

The bill presented in the House by Rep. Mansfield, chairman of the Rivers and Harbors Committee, establishes the same constitutional base but is limited to planning. This measure seems to conform more nearly with the plan outlined by the President in his recent message to Congress.

The authorities proposed by Senator Norris are of the TVA type. Under his bill they would have broad administrative powers. The Mansfield bill is an effort to profit from the work of the Water Resources Committee, which has made it very clear that planning has been haphazard in character. It is intended to satisfy the public demand for systematic conservation that has been prompted by flood and drought and dust disaster—problems that are too big for any locality to handle. It would put planning on a basin basis rather than on a project basis.

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Pennsylvania's Grant Term Liberalized by PWA

Revised terms for grants to the state of Pennsylvania for use in a $65,000,000 institutional building program were announced June 10 by PWA after several weeks of negotiation. Under the new offer PWA will make an outright grant, without restrictions, of $10,000,000, in addition to which it will grant 133⅓ per cent of wages to labor taken from the relief rolls. The combined grant total will not exceed $20,000,000. The building program comprises 80 different projects located in all parts of the state, and included schools, hospitals, welfare institutions and other public buildings.

Liberalization of the grant's terms was made in response to arguments that, because of certain legal restrictions, the state has hitherto been unable to participate in the PWA construction program to the extent justified by the relief load.

Cincinnati Building Strike of Common Labor Settled

The strike of Cincinnati building laborers called by the Hodcarriers and Building Laborers Union on June 1 (*ENR*, June 10, 1937, p. 851) which had halted construction totaling $15,000,000, was settled June 11 when the building division of the General Contractors Association agreed to the demands of the union that common laborers receive a scale of 75 cents an hour. The previous scale was 60 cents.

Contractors took this action when the union rejected a compromise proposal for a scale of 70 cents an hour from June 1 to Jan. 1 and 75 cents thereafter. The new scale will remain in effect until June 1, 1938. A dollar rate for hodcarriers had been agreed to.

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Colonel Peek Is Promoted to Brigadier General

The president has sent to the Senate a nomination of Colonel Ernest D. Peek for the position of Brigadier General of the Line. Col. Peek is now division engineer at New York City. He will succeed Brig. Gen. Charles D. Roberts who retires June 30.

Col. Peek graduated from West Point in 1901, and his early service included participation in the suppression of the Philippine insurrection and river and harbor improvement work in various sections of the United States. During the World War he organized and commanded the 21st Engineers and was later chief engineer of the First Army and deputy director-general of transportation for the A.E.F.; he received the Distinguished Service medal for exceptionally meritorious service in organizing and operating the railroads in the zone of the advance.

After the war, Col. Peek served in the office of the assistant secretary of war, was a member of the general staff in Panama, was on duty in the inspector-general's department, and was engaged in river and harbor improvement work.

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Tunnel Held Intangible by Illinois Court

The Illinois Supreme Court on June 11 held that a tunnel is not taxable because it is intangible.

The county treasurer had tried to collect taxes on the under-river tunnels of the Chicago Railway Co. The street car company refused to pay and was upheld by the Cook County Circuit Court. The Supreme Court in affirming the findings defined the tunnels as "merely intangible items on the company's capital account."

States Are Acting on Soil Conservation

Washington correspondence

Private land owners in the dust bowl did as they pleased and disaster resulted. If authority were given a bureau in Washington to say what they should or should not do many objections would be raised. The administration proposed that such problems be met by the establishment of soil conservation districts under state laws. Eighteen states have adopted such legislation this year. Four other states are expected to act before their legislatures adjourn. Other states are expected to follow suit as their legislatures meet.

As the law was enacted in most states rules with regard to erosion control and other conservation measures are to be applicable to the entire district if they muster a majority vote. In this way strip farming, contour ploughing and all manner of rules and regulations can be made effective. If a rule is adopted, for instance, that only trees or grass may be planted where the slope exceeds eighteen per cent the district can vote compensation to members upon whom such a rule might work a hardship.

States that have adopted soil conservation district laws are: Arkansas, Indiana, North Dakota, South Dakota, Utah, New Mexico, North Carolina, Nevada, Georgia, Kansas, Maryland, Oklahoma, South Carolina, Minnesota, Colorado, Nebraska, Florida, New Jersey. The measure has not been acted upon finally by the legislatures of Pennsylvania, Michigan, Wisconsin, and Illinois.

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Third Engineer Dismissed in Pennsylvania Scandal

The gravel scandal in the Erie district of the Pennsylvania Highway Department, which has already resulted in the dismissal of Chief Engineer H. A. Temple and District Engineer E. A. Griffiths (*ENR* June 10, 1937 p. 854) has caused the further dismissal of Mark Finneran, engineer in the Erie district, suspended since April 1 for "general neglect of his duties". He has now threatened to bring civil action against Warren Van Dyke, secretary of highways and Arthur Colegrove, secretary of property and supplies.

At the time of announcing Mr. Finneran's dismissal, Mr. Van Dyke said he planned to transfer other men and bring in new ones to the Erie district in order to improve the service and morale.

Rot Causes Failure Of Timber Bridge

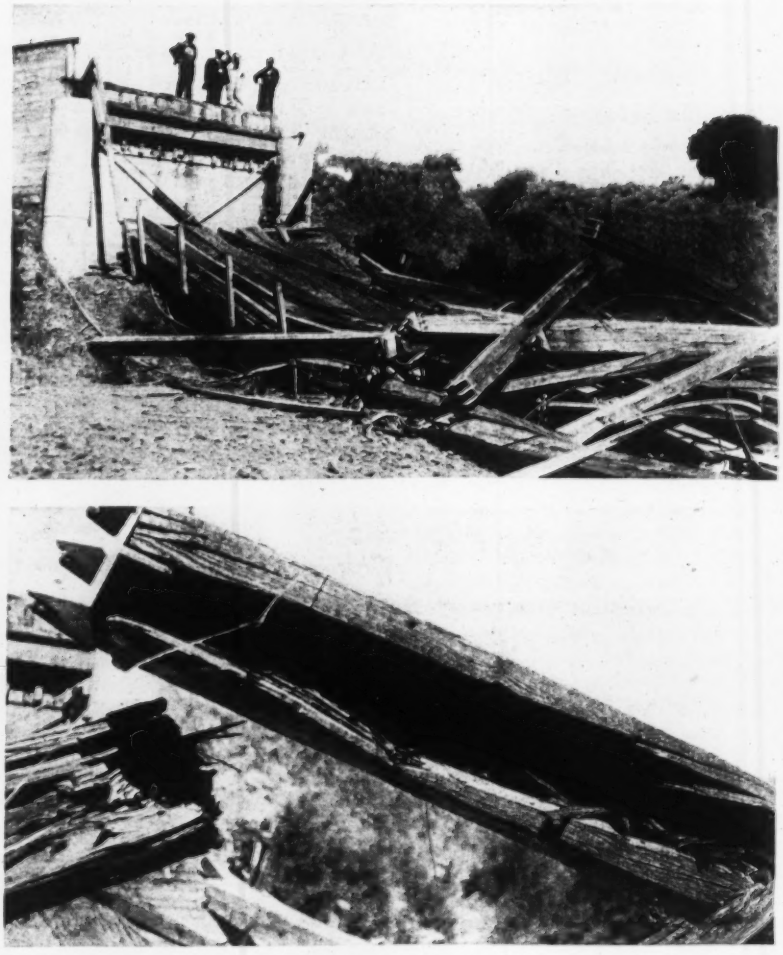
Timber and steel bridge in California fails under load when dry rot attacks timbers

An old county bridge across Tres Pinos Creek in San Benito County, Calif., collapsed May 27 under a loaded lumber truck whose gross weight was about 16 tons—within the legal limit for the 6-wheel truck used.

The bridge was an 80-ft. through Pratt truss made up of four 20-ft. panels. The roadway was 14 ft. wide and about 18 ft. above the creek bed. The top chord and inclined end posts were composed of 10x12-in. timbers, and the bottom chords were steel eye-bars; compression verticals were 6x8-in. timbers, and the inclined web members were steel eye-bars with round rod counters. The connections at the panel points were made with cast iron shoes and steel pins.

The condition of the wreckage indicated that failure probably occurred first in one of the top chord timbers close to the center line splice. These top chord members had become dangerous because of dry rot, which had progressed so far that in places more than 60 per cent of the cross section was completely destroyed; the rotted wood could be pulled out and crushed with the bare hand. Apparently the extensive rot and deterioriation had not been evident to casual inspection from the roadway.

A stress analysis of the truss indicated according to H. M. Engle, structural engineer, San Francisco, that if the members had been in good condition, collapse would not have occurred under the 16-ton load. Even with 100 per cent impact, the stresses were well within safe limits.



BRIDGE FAILS IN CALIFORNIA

DRY ROT caused the failure of timber members in this old county highway bridge. It may be seen in the lower picture how nearly two-thirds of the cross section in the top chord member had been rotted away.

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Spillway Work Begins on San Gabriel Dam

Construction of the spillway on San Gabriel Dam No. 1 of the Los Angeles County, Calif., Flood Control District, has been begun by the Los Angeles firm of Gobo & Rados which has been awarded the contract on its bid of $314,000. Completion of the spillway by Sept. 15 is anticipated.

When the San Gabriel Dam No. 1 is finished this fall, it will provide storage for 56,000 acre-ft. of water, relieving the Pasadena Morris dam of the heavy burden that it has carried alone with its 38,000 acre-ft. capacity for the past three years.

In voting to award the spillway contract, the supervisors decided not to wait for a possible PWA allotment, which would have delayed construction to a point where the dam could not be used until the water of the 1939 season had been stored. Such a loss of a season's water, it was estimated, would have prevented the country from storing $750,000 worth of water behind its dam next winter.

• • •

Richelieu Dam Approved by Joint Commission

The International Joint Commission of Boundary Waters, sitting in Montreal on June 10, announced unofficial approval of the proposal of the Dominion Government of Canada to construct a dam across the Richelieu River at an estimated cost of about $500,000. The scheme includes excavation of an enlarged river channel through a natural barrier near St. John, Que.

Two Contracts Let for Work on All-American Canal

The Department of the Interior has awarded two contracts for the construction of the New River siphon, three highway bridges, and two canal turnouts, near Calexico, Calif., on the All-American Canal. The first contract, for construction of the inlet and outlet works of the siphon and the bridges and canal turnouts, was awarded to the Sharp & Fellows Contracting Co. of Los Angeles on its bid of $270,000. The second contract, covering fabrication and installation of the steel plate barrel of the siphon, was awarded to the Southwest Welding & Mfg. Co. of Alhambra, Calif. on its low bid of $111,000. The successful bids were each the lowest of 14 proposals.

The New River siphon, 15.5 ft. in diameter and 508 ft. long, will cross the gorge of the New River.

Harrison P. Eddy Dies in Montreal

Harrison P. Eddy, a leader of the civil engineering profession and dean of the sanitary engineers of this country, died on June 15 in Montreal, where he had gone to receive honorary membership in the Engineering Institute of Canada at its semi-centennial meeting. Mr. Eddy, who had driven from Boston to Montreal with his family, was stricken with a heart attack Monday.

Harrison Prescott Eddy had been outstanding in civil engineering for forty years. Born in Millbury, Mass. in 1870, his early training and practical experience was gained in New England, where he took up sanitary engineering work immediately upon graduation from Worcester Polytechnic Institute, in 1891. In that year he was appointed superintendent of the sewage treatment plant at Worcester, and the following year was appointed superintendent of the sewer department of the city, work which included entire charge of design and construction.

Mr. Eddy continued at Worcester until 1907, when he went into private practice with Leonard Metcalf under the firm name of Metcalf & Eddy. That association was dissolved by Mr. Metcalf's death in 1926, but the firm name was continued with Harrison P. Eddy, Almon L. Fales, John P. Wentworth, Charles W. Sherman, Frank A. Marston, Harrison P. Eddy, Jr., Arthur L. Shaw and E. Sherman Chase as members.

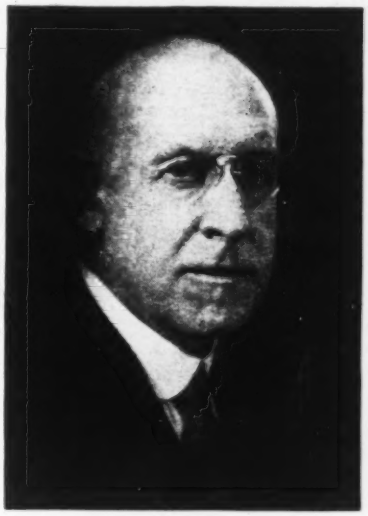
As a member of the firm of Metcalf & Eddy, Mr. Eddy acted as consultant on problems of water supply, sewage and waste disposal for nearly one hundred cities, including Chicago, Cincinnati, Buffalo, Dayton, Milwaukee, Cleveland, New York, El Paso, New Orleans, Detroit and Washington. Outstanding among these undertakings was his work on the design of the sewerage system of Louisville which brought him national recognition and his study of sewage disposal and water supply for Milwaukee.

Mr. Eddy also served in an individual capacity as a member of numerous boards and commissions, most notable of which was the engineering board of review of the Santiary District of Chicago. In recent years he was a member of the PWA board of review.

Mr. Eddy took an active part in the affairs of technical and professional societies, including the American Society of Civil Engineers and the Boston Society of Civil Engineers, of which organizations he was a past president; the American Water Works Association, the American Institute of Consulting Engineers, and the American Public Health Association. While serving as president of the American Society of Civil Engineers, Mr. Eddy devoted much effort to improving the compensation of engineers in public service, especially those employed by the many federal emergency organizations.

The following appreciation of Mr. Eddy was written by his associate of many years, Charles W. Sherman:

"With the passing of Harrison P. Eddy the engineering profession has lost one of its outstanding members. In his special field of sanitary engineering



HARRISON P. EDDY

he was probably the most eminent American practitioner at the time of his death.

"Professionally, Mr. Eddy was characterized by thoroughness, sound judgment and an enormous capacity for hard work. To an uncommon degree he possessed the judicial habit of weighing all the evidence before reaching conclusions. Cautious and conservative by nature, he did not hesitate to adopt new ideas and methods when convinced of their merit but his convictions were based upon the best evidence available. He could not be stampeded by generalities or by persuasive but unsubstantial arguments.

"Personally, Mr. Eddy was a man of high ideals and moral standards. His consideration of others, his kindliness and his sense of humor endeared him to all those privileged to be his associates in any activity. Those who knew him intimately felt that here was a man whose every human relationship was guided by the principles of the Golden Rule.

"Afflicted for many years with an incurable heart disease, he carried on without flinching, without complaint and with quiet courage. Notwithstanding the shock of his sudden death, it is gratifying to recollect the lasting imprint his ability and character have had and will continue to have upon the practice of engineering."

Robert Spurr Weston, Boston consulting sanitary engineer, says of Eddy: "His forty years of intensive practice produced many masterpieces of sanitary engineering. He and his work gave added dignity to the profession. Great in human understanding, he leaves not only works to mark his memory but friends who mourn his going but will go on, inspired by his work in life. A great leader of the profession has passed on at the time of his fullest usefulness and at the height of honor."

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

RECOGNIZING that no general federal reorganization can get through, administration efforts now are being concentrated on saving parts of the plan. A quiet effort is under way to get the six "anonymous" assistants for the President without waiting for action on other phases of the bill.

A public hearing will be held in the Municipal Auditorium, Springfield, Mass., on June 30 to discuss proposed flood control works in Connecticut and Massachusetts, according to an announcement by the Board of Engineers for Rivers and Harbors.

Senators Tydings and Radcliffe of Maryland on June 10 introduced a joint resolution permitting the states of Maryland, Virginia, West Virginia and Pennsylvania to negotiate a compact for the creation of a Potomac Valley Conservancy District for the purpose of regulating stream pollution along the Potomac River and its tributaries.

President Roosevelt has approved bills authorizing the states of Maryland and Virginia to construct and operate a free bridge across the Potomac River near Point of Rocks, Md., to replace a bridge destroyed by flood in March, 1936; authorizing Wahkiakum County, Washington, to construct and operate a free highway bridge over the Columbia River connecting Puget Island with the town of Cathlamet, and extending the times for starting and completing bridges between Dauphin Island and Cedar Point, Ala., and over the Mississippi River between St. Louis, Mo., and Stites, Ill.

(*News continued on page 924*)

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Engineers and Unions

Sir: In all the present discussion on the maintenance of the professional character of engineering against labor unions for "skilled technicians", the most outstanding omission is the matter of the employment situation in engineering.

Big business has changed, and probably has eliminated, what may be called rugged individualism in engineering. There was a time when an engineer was permitted to set up an office and to carry on his work on a professional basis, similar to the practitioner in medicine or law. Nowadays it is impossible for the engineering graduate to open a professional office unless he has sufficient funds to carry out the large contracts of today. But even if funds were available to compete against the large construction companies of today, the young engineer is not legally permitted to maintain that office unless he has a license.

Now, the college graduates of other professions, medicine and law for example, are given the opportunity to obtain their licenses practically at graduation. In engineering, the graduate must wait at least five years while he gains experience in a "responsible position." After that period, assuming he has spent only five years in gaining the required experience, he must suffer, as the Spaniards say, an examination which includes subject matter the engineer has passed over several years previous to graduation and which he has not touched since that time. The opportunity for obtaining a professional license in engineering is less than in other professions, and this condition has come about through the efforts of the professional societies.

The writer does not chide these societies for their activities in maintaining a high standard in the profession. But it must be evident that while our graduates are working through their five years of experience they are merely employees, or skilled technicians. During this period their salaries are low as compared with those of the skilled trades. An increase in salary to a "sub-professional" standard becomes possible only through concerted action—hence the labor union. Today, the engineer is primarily an employee of big business; he is not a professional man in the sense that he works on his own. While today he holds himself aloof from the labor unions, later he may find it a necessity to become a member.

There are engineers who resent the labor union. They may or may not have professional licenses. But while they are mere employees they will remain underpaid. The writer does not suggest any solution in the discussion. Perhaps the professional societies will find one. But in the course of their study they must overlook the matter of a license; their solution must embrace all engineers, else there will be a complete cleavage between the employer-engineer and the employee-engineer, as indicated in the editorial "Unionization of Engineers" in your issue of May 27.

Bronx, N. Y. LOUIS ROBERTS
May 29, 1937

Drivers to Blame

Sir: I am not at all in accord with the thought which apparently inspired the editorial entitled "Unfamiliar Roads" in your issue of May 27. I agree, of course, with the idea that highways should be properly designed, by competent engineers, after adequate study. I believe that proper warning signs should be placed along our roads, but I think the blaming of engineers or highway authorities for the kind of accident referred to in your editorial is not warranted.

All general reports and statistics of accidents lay most of the blame on the drivers. It is true that faults of the highway, if such there be, may not be recorded or observed. I myself have driven a car for thirty years without a serious accident (I am knocking on wood). I have driven over many hundreds of miles of unfamiliar roads, and have been driven over all kinds of roads, and in places where there were no roads, in a good many different countries, and I am convinced that pretty nearly 100 per cent of all highway accidents are caused by careless drivers.

I repeat that I am all for proper study, design and construction which is based on adequate provision for the traffic, and for the operating requirements of the vehicles. I don't think there can be too much or too often repeated emphasis on the need of this, but I am not convinced that the roadbuilder is to blame for motor vehicle accidents.

New York City, June 10, 1937 FRED LAVIS
Consulting Engineer

Flood Control

Sir: Your engineers appear to have lost sight of the fact that a river with its alluvial plain is a natural phenomenom.

Possibly because your rivers have been controlled and denatured for several generations, they have come to regard the river as a flood menace, and an arch destroyer to be fought and beaten, rather than nature's builder of the rich and fertile flats.

The essential point is that all such rivers carry silt, which must be deposited; if the river is controlled by levees, the silt can no longer be deposited on the river's flood plain but must be carried out to the river's mouth where it will be deposited in the building of the plains of the future, and in the lengthening of the river. The river to get its discharge must therefore raise its bed; this must raise its flood levels and the levees must be raised to prevent overtopping; to this process there is theoretically no end, but the time must come when it is no longer feasible to raise the levees higher or to increase the river's grade by straightening.

For 32 years the writer has practised engineering on alluvial plains, 28 years on the plains of the Brahmaputra (a river whose discharge is equal to that of the Mississippi) and its many tributaries, and 4 years on the plains of the Tigris and Euphrates. Obviously, in your highly developed and protected plains, conditions are totally different from the wet rice cultivated plains of Bengal and Assam, but the essentials of the river regime are the same.

Your engineers appear to be obsessed with the problem of how to

protect the interests that have grown up under flood protection. Nowhere in all the articles that you have published in the past many years has the writer seen any appreciation of the fact that the many flood control schemes put forward are but temporary alleviations of the present dangerous conditions.

Some scheme must be evolved to build up the plains with river silt, first to replace the natural growth of which they have been robbed during the past eighty years of levee protection and after that to keep pace with the river's natural growth.

A recognition of this vital aspect of the problem is essential if the river plains are to be engineered so that posterity may enjoy them in perpetuity. Once this is recognized the ingenuity and undoubted skill and capacity of your engineers with the enormous resources at their disposal should find a final solution of the problem.

To the writer the only solution appears to be that of controlled spillways designed to flood and build up sectional areas, each with its discharge canal back into the parent river. Under such a scheme large blocks of country would have to be taken over by the State for the period of their reconditioning.

Chittagong, E. Bengal, India
April 30, 1937

FRANK J. SALBERG

A New Type of Crest Gate

Sir: Considering the very numerous movable gate designs conceived by a great many engineers past and present, it is somewhat of an undertaking to proclaim and announce a "new crest gate for dams" found on p. 665 *Engineering News-Record* of May 6.

Fig. 1 shows a lift-Tainter design prepared by the writer twenty years ago for an irrigation project in Siam; size of lift Tainter 41 by 24.7 ft. high. The design was not new then. It was merely an adaptation of the rolling lift Tainter built by the Maschinenfabrik Augsburg-Nurnberg in Kibling, Germany, by still further reducing the rolling pin into a sliding pin.

The cost of the Tainter is only part of the total cost. Looking at the expensive, enormous 70 ft. piers shown on p. 665 for a dam having a head of only 18 ft. it is recalled that until recently the U. S. Engineers built for many decades such low, movable dams, without piers at all patterned after a type originated by Poirée in the year 1834 at Basseville, France. The Chanoine type, originated in the Seine at Courbeton in 1850, and the Pasqueau design, built first in 1879, were extensively used without piers by the U. S. Engineers on the Kanawha, Ohio and other rivers.

For the last 30 years or so the tendency in Europe has been to subdivide the dam into large openings regulated by single units which can be operated more quickly than the old Poirée, Chanoine, Pasqueau, Thénard and other types. Some of these types are also quite ancient in origin, but are still in use and require only low separating piers, as for instance the many forms of drum dam and beartrap.

Where a low dam is built in a river having very high flood stages the modern forms of beartrap are most favored, as they do away entirely with the huge piers, are quickly operated, very light and low in cost, adaptable for automatic operation, while repairs and accumulations of sand and gravel are efficiently taken care of.

For low dams in rivers with very high flood stages the Stoney, roller and Tainter gate dams are neither adaptable nor economical. The gates have to be lifted high over the water level and require considerable clearance over the highest flood level. The Emsworth dam shown on p. 666 requires piers 66 ft. above tailwater! Roofweirs can be operated quicker than either roller, lift, or lift-Tainter gates, and they do away with the very large piers, the cost of which should be figured when comparing different types of crest gates.

Comparing the Stoney, roller and Tainter gates, the latter have always been very popular in this country on account of their low cost.

Tainter gates are really of French origin, having been built by Poirée in 1853 and around 1860 in the famous Rosetta barrage in the Nile delta. It is said that Parker sold the idea to Tainter, who patented the design in 1886.

The roofweirs, if applied to the Emsworth dam, would weigh less than either roller, lift or lift-Tainter gates. The comparison follows, a gate size of 100 by 11 ft. being assumed.

Roller gate	175,900 lb.
Lift gate	157,400 "
Lift-Tainter	120,880 "
Roofweir	80,000 "

The great saving however consists in the elimination of the enormous piers, which in addition to their great cost also considerably restricted the channel area.

In conclusion it may be said that for canalization of rivers with very high flood stages, preference should be given to movable dams requiring only low separating piers. Since the old designs of the disappearing type of Poirée, Chanoine, etc., can now be supplanted by large units of the beartrap type which are not only low in cost but in every way satisfactory in operation, there is no incentive to use the roller, lift or lift-Tainter types which require very large piers in addition to being heavier and higher in cost, requiring footbridges, operating bridges and hoists.

Far from being a new type of crest gate, the lift Tainter was originated more than twenty years ago. The gate shown in the drawing below was not built due to contract difficulties.

Jackson, Mich.
May 11, 1937

A. STREIFF

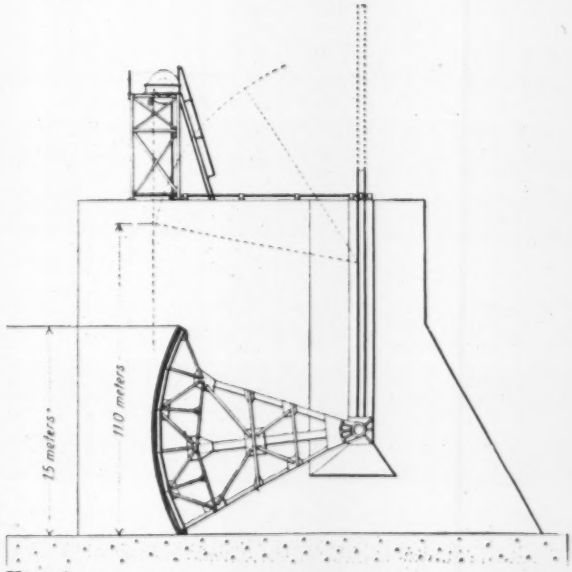


Fig. 1. Lift Tainter gate designed in 1917 for an irrigation project in Siam.

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JUNE 17, 1937

BRIDGE FAILURES of the kind reported on page 894 emphasize the importance of regular and adequate inspection. In this latest instance 10x12-in. timbers had rotted until nearly two-thirds of their cross-sectional area had been destroyed. With principal members of a structure in this condition, anything worthy the name "inspection" would have prevented the accident and saved officials from criticism and embarrassment. Such bridges are used the country over by school buses; even in the case of small structures a complete collapse of this sort may be serious in loss of life. Yet unfortunately there is a tendency on the part of some county officials to assume that satisfactory service over a long period proves that a bridge is safe. The truth is that the older the structure the greater the need for inspection.

A Master Plan

PLANS for national highways usually get little consideration, and rightly so. The lack of logic in their conception and engineering amply justifies legislatures and public-roads officials in ignoring them. But the master plan for a highway system development in the United States set forth in this issue by a well known and eminently practical highway engineer is of quite different kind. It is founded on logic and has reasonable claim to practicability. Though the statement and argument as published are necessarily of utmost brevity, they contain little that can be questioned. The roads designated are all needed now, or else their future need is beyond doubt. The claim of earnings is justified by past experience, and road users are now paying in taxes enough to build the roads in a reasonable time. The plan is practicable, and can be carried out if all who are concerned in road transport will work for it with sure purpose.

Business Principle

IF FOR NO OTHER REASON, the order of the state Public Service Commission to cities in New York State to reduce rates of their public utility plants to a reasonable return is commendable because it will require correct accounting and straightforward business practice in the financial management of such municipal services. The unsatisfactory nature of public service accounting is notorious. Only few municipal services can give even a rough figure for their total investment or for the value of used and useful plant. Quoted capital charges generally include nothing beyond interest on the outstanding bond residue. Such accounting completely distorts the operating picture of public business, and renders impossible any sound and justified conclusions concerning operations, or betterments, or profit and loss, or rates. Once the principle is enforced that service rates charged by cities must be related to cost of service and reasonable return, good business practice is bound to follow. Such reform will benefit both the service and the public.

On the Way

A NEW ERA of waterworks progress was definitely indicated by the Buffalo convention last week. The American Water Works Associaton's program of half a hundred papers, together with many committee reports, showed varied and busy activity. The waterworks practice committee, which is a committee of committees whose efforts ultimately find publication in pamphlet form pending revision of the Association's manual, received a surprising number of finished reports. Differences of opinion between representatives of manufacturers, water officials and engineers are being composed. After more than a dozen years, agreement on a specification for pit-cast cast-iron pipe appears possible. Similarly specifications on valves, gate valves and hydrants are essentially complete. An accounting manual under preparation also promises to be of value. Other evidences of rejuvenation of waterworks growth were not wanting. The reorganization of the association last winter appears to be justified by its results; the association is on its way toward serving adequately the most vital of the group of public utilities.

Waterway Economics

THE ST. LAWRENCE RIVER provides Canada with a great national waterway extending far into the interior of the country. Ocean liners are able to travel several hundred miles inland to Montreal, making that the greatest grain handling port in the world. But in recent years low water in the upper part of the waterway, especially in Montreal harbor, has made navigation difficult. At times it has required vessels to take on but part of a cargo, going down to Quebec to complete the loading. As a result many proposals for improving navigation conditions in the river have been put forward, in fact so many that some years ago the govern-

ment set up a board of engineers to report which if any of them should be adopted. Americans will find the board's report, summarized in last week's issue, noteworthy in this respect: though the St. Lawrence is Canada's principal outlet to the Atlantic Ocean the board finds that the return to the *nation* from improvements resulting from either lock and dams or from weirs and channel- contraction work would not justify the large cost of either. In this country when a waterway is being studied the benefits to shippers and shipowners are set over on the credit side of the ledger with little regard to how much of it will get back into the national treasury. The Florida Ship Canal, now well on its way to Congressional approval, is a good example. If more of our waterway projects were subjected to the critical study given to the St. Lawrence we would waste less public money.

River Conservation

IT IS ENCOURAGING to observe from the President's recent river conservation message that guardianship and care of the country's water resources has at last received authoritative recognition. These vital resources, neglected for many years, have had no planning except for local or narrow purposes, under which proper conservation and effective utilization could not be attained. Now that the need for all-inclusive attention to river conservation is formally recognized by the government, the development of rivers enters a new stage.

The slow growth of appreciation of rivers as an important part of our national estate was accelerated in recent years by the compelling force of events. Drought and flood visitation since 1930 played their part, but even earlier the same lesson was being taught by increasing water needs, by trouble from pollution by acids, sewage and soil waste, by intensification of water needs, and by disputes over river jurisdiction. It is significant that nearly all national improvement works of the last decade or more, aside from road construction, have centered on rivers. The future will see rivers occupy even a more central position.

The President proposes immediate organization for planning of river resources, and suggests that to this end the United States be divided into seven regions, with a planning body for each. As was to be expected, some elements in Congress are seizing on the message as a welcome occasion to promote their desire for increased federalization and for public power development, even at the risk of defeating real conservation and reclamation of values. Others, more moderate in their views, lean to the establishment of regional planning boards in accordance with the President's recommendation. In this difference of ideas the whole question of whether river development is to go forward in sound and constructive manner is at issue.

As to planning, the experience of recent years shows that we know too little about rivers for any comprehensive planning. Further, we have not yet learned how to plan. The four years of existence of what originally was called the National Planning Board shows that the only substantial accomplishment is last year's river inventory or drainage-basin survey—and the very engineers who made that survey say that it is only a preliminary for further study. Were a commission or board to undertake development and conservation planning for the scores of streams on the Atlantic Coast, for instance, it would have to go through many years of preliminary study before it could possibly make any considered recommendations.

Next, as to the experience with river Authorities, we have the Tennessee Valley Authority as only present example. That body's record unfortunately proves nothing pro or con. As was indicated by a group of articles on the TVA that we published last December, the TVA throws no light on either the economics of river development, or administrative methods suitable to the purpose, or methods of bringing about regional cooperation, or procedures for financing.

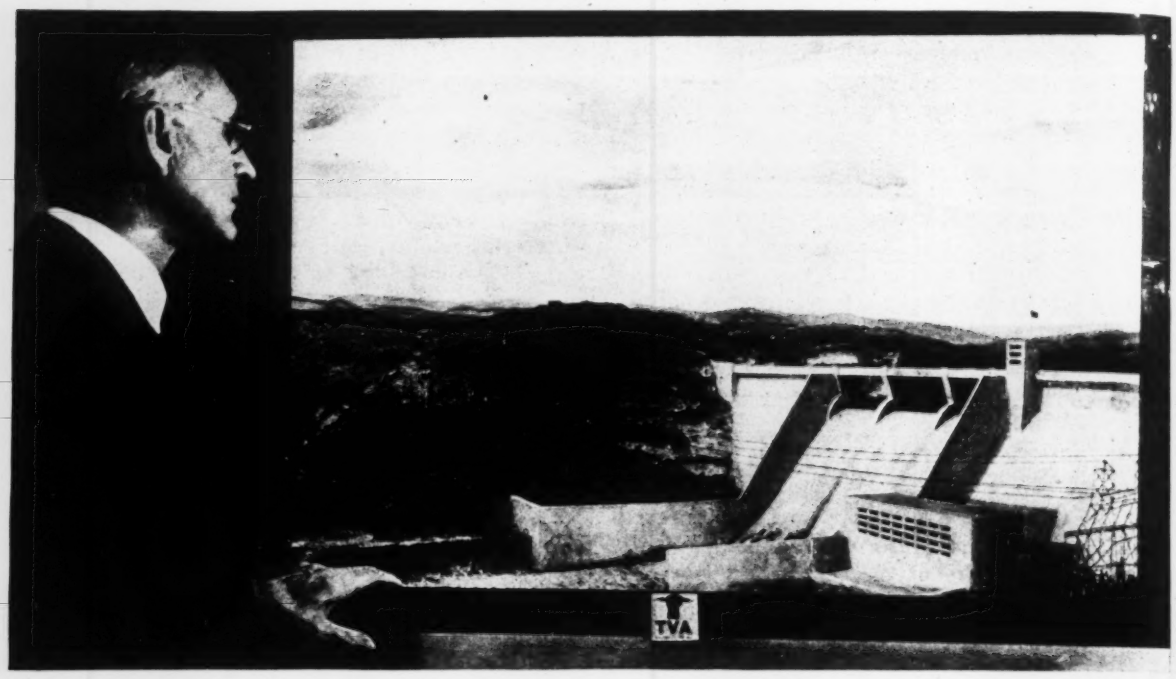
Local authorities of comparable nature, such as the Brazos River Conservation District in Texas, make even worse showing in lack of accomplishment. The obvious conclusion is that we are far from ready to set up more authorities, except as mere devices for the quick and painless expenditure of public funds.

Despite this unpromising experience, river study is unquestionably urgently needed. Planning also is needed, when and as the study shall have advanced sufficiently. But the time for effective planning cannot be reached until years from now, and in the meantime many river questions must be dealt with. Already we face urgent problems of conservation, of water allocation, of purification, of floods, of water supply, and in minor degree also of power and navigation.

A practical approach to these problems may be made through boards set up to deal with individual rivers. A single board of local membership to study and administer the problems of the Connecticut, for example, could accomplish useful results at an early date. Its work, moreover, could readily be coordinated with broader regional questions, given reasonable intelligence and breadth of view on the part of the board.

Such planning for single rivers would give assurance of businesslike attention to economics, to basin development and to equitable care of all interests concerned. It offers a way out of the difficulties that are inseparable from either the Norris Authority plan or the President's regional planning proposal.

PICTURES IN THE NEWS



ARTHUR MORGAN, chairman and chief engineer of the TVA, examines a diorama of Norris Dam that is to be shown at the Paris International Exposition this summer.

FILLING of the 400-acre site for the Golden Gate International Exposition is practically completed and work on the great hangars that will serve as temporary exhibit halls during the fair is well along. Photo by Clyde Sunderland

New Road Under the Hudson

Lincoln vehicle tunnel under the Hudson River at New York will link New Jersey with the central Manhattan business district and form part of future through highway route to Long Island

To cope with the ever-increasing trans-Hudson River vehicle traffic at New York City, a new subaqueous tunnel is being built from New Jersey to 39th St., Manhattan, at a cost of $85,000,000. The Lincoln tunnel (formerly the Midtown Hudson Tunnel) will be a mate to the famous Holland Tunnel, three miles downstream, and, with the George Washington Bridge seven miles to the north, becomes the third vehicle traffic structure across the Hudson at New York. However, the Lincoln Tunnel occupies a more strategic position than do its neighboring traffic routes, for it leads directly into the midtown business district of Manhattan and lies in a direct line with the new Queens Tunnel now being built across the East River between 38th St. and Long Island City. There is considerable agitation for a cross-town tunnel to connect the two river tubes and thus provide a through underground route from New Jersey to Long Island, with surface connections at the east and west fringes of Manhattan Island. In all probability this connecting link will be built in the near future.

Traffic demands new route

Not long after the Holland Tunnel was opened to traffic in 1927 the Port of New York Authority, which was already engaged in the construction of the George Washington Bridge,

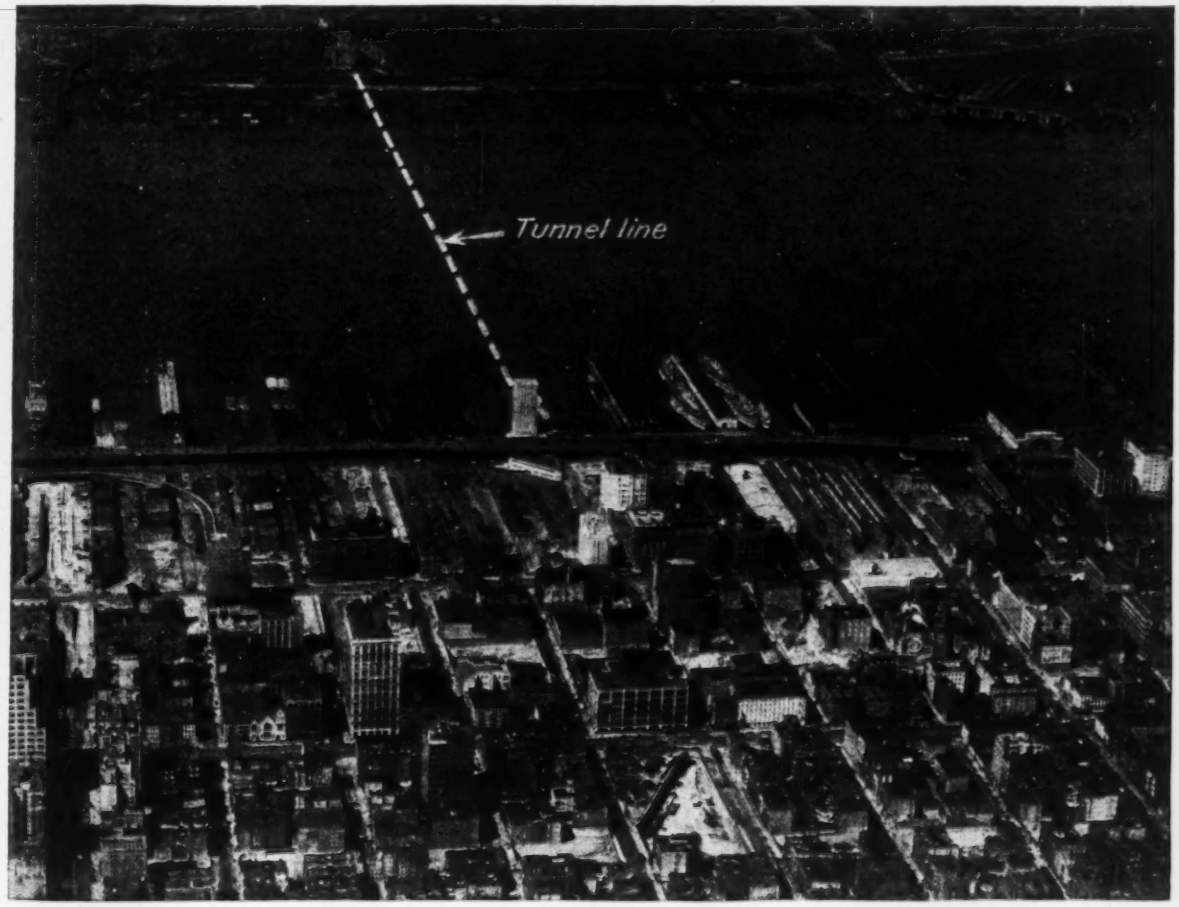


Fig. 1. Route of the new road under the Hudson. In the foreground is the Manhattan plaza for the south tunnel (right center) and the new street cut from 34th St. on the left to 42nd St., on the right. The three tall buildings in line with the tunnel are ventilation shafts.

Aerial Explorations Photo

made further studies of potential trans-Hudson vehicle traffic. Early in 1930 that body submitted a report to the two state legislatures showing that within a decade or so the cross-river traffic would tax the capacity of Holland Tunnel, the bridge and the ferries. In view of this, the Port Authority recommended construction of another tunnel from 38th St. Manhattan, to Weehawken, N. J. Its report stated further that by 1948 traffic across the Hudson would probably reach 75,000,000 vehicles annually, just five times the number recorded in 1915. The 1948 traffic, according to the studies, would be distributed as follows: Holland Tunnel and Midtown Tunnel, 18,000,000 vehicles each, which would load these tubes to capacity; George Washington Bridge, 26,000,000 vehicles, ferries, 13,000,000 vehicles.

In March, 1931, the legislatures of the two states authorized the Port Authority to proceed with construction of the Midtown Tunnel, designated to run from some point between 35th and 40th Sts. on the west side of Manhattan, to Weehawken, with an extension of the route either by tunnel or open cut to the Hackensack meadows on the west side of the Palisades upon which Weehawken and adjacent Union City are located. At the same time the Port Authority was given full jurisdiction over interstate traffic facilities (other than ferry) through absorption of the New York and New Jersey tunnel commissions that built and were operating the Holland Tunnel. The Holland Tunnel financial structure was combined with that of the Port Authority, and refunding bonds were issued by the Authority to repay funds advanced by each state for construction of the tunnel.

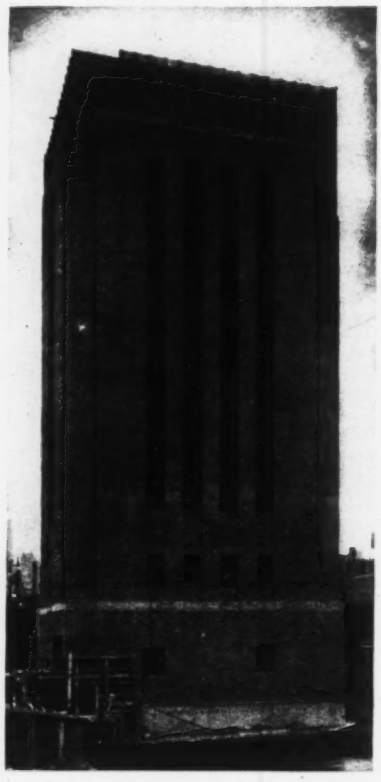


Fig. 3. Fresh air is vital to the under-river motorist. This is one of five ventilation plants that have a combined capacity of nearly 9,000,000 cu. ft. of air per min.

The Port Authority was at that time unable to arrange for private financing of the proposed tunnel, for the country was by then in the grip of the business depression. Consequently, construction of the tunnel was postponed for the time being.

PWA loan for single tube

In 1933 negotiations were carried on first with the RFC and later with the PWA which in 1934 led to a loan from the government, of $37,500,000. This amount would permit the construction of only one tube and necessary approaches, studies having indicated that it was practicable to build

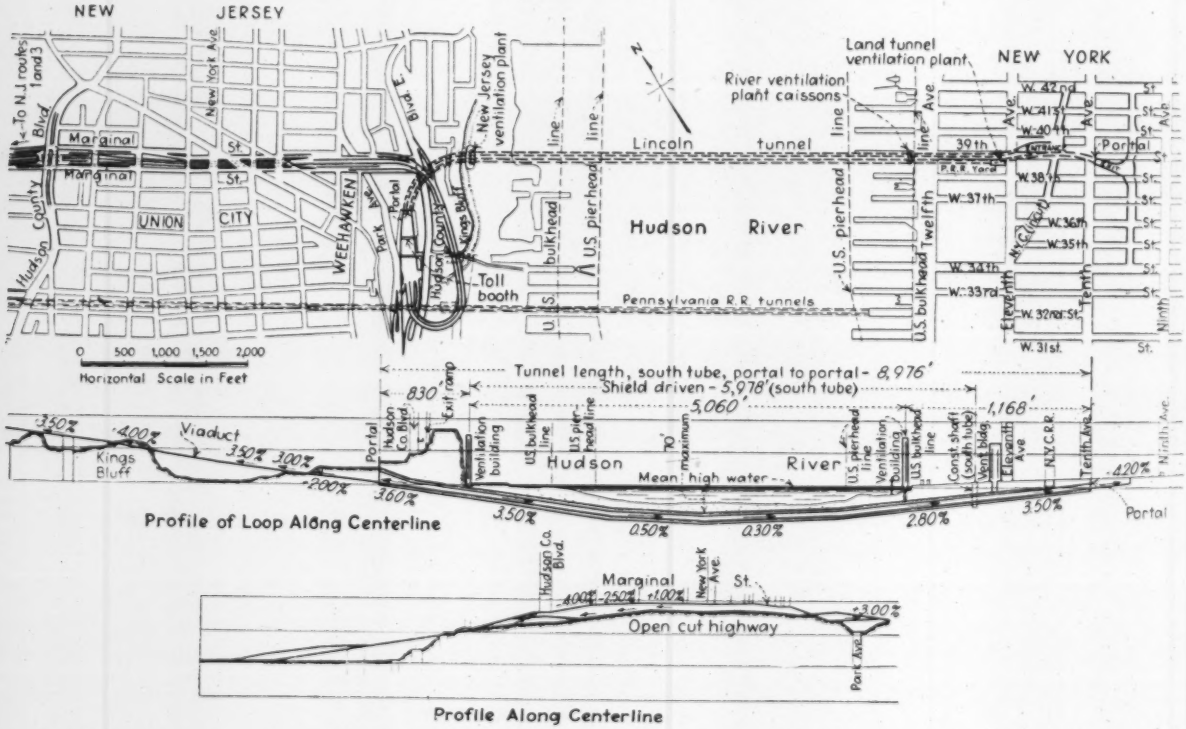


Fig. 2. The Lincoln Tunnel will be the third direct highway connection across the Hudson from New Jersey to Manhattan. Details of the New Jersey approach road to the west of Park Ave. as shown here are only tentative.

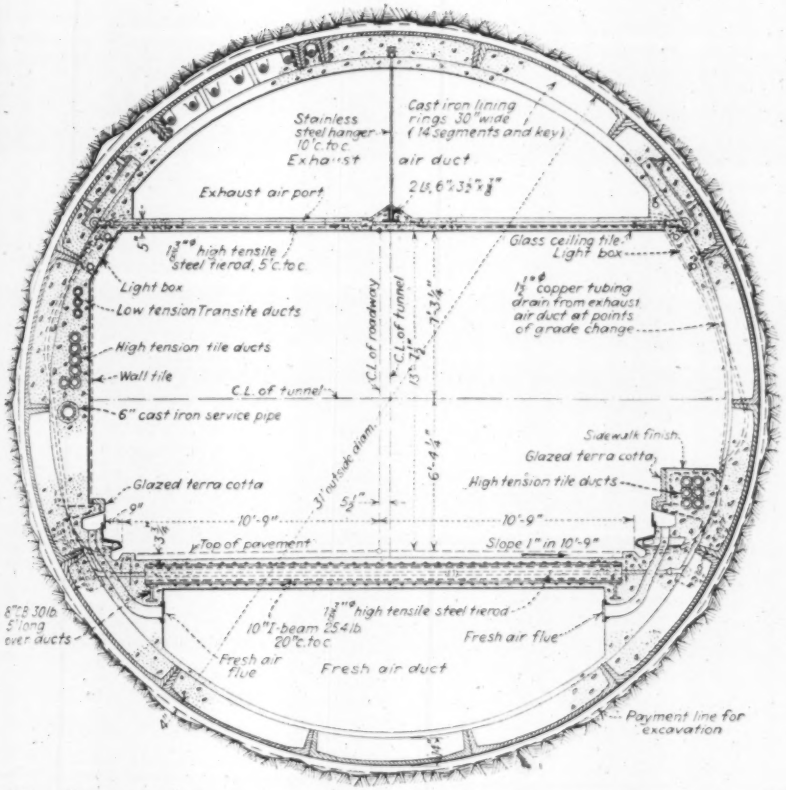

Stainless steel hanger 10'C. to c.
Exhaust air duct
Cast iron lining rings 30" wide (14 segments and key)
Exhaust air port
Glass ceiling tile
Light box
1⅛" high tensile steel tierod, 5' c. to c.
Light box
Low tension Transite ducts
High tension tile ducts
Wall tile
C.L. of tunnel
6" cast iron service pipe
C.L. of roadway
C.L. of tunnel
1½" copper tubing drain from exhaust air duct at points of grade change
Sidewalk finish
Glazed terra cotta
High tension tile ducts
Glazed terra cotta
10'-9"
10'-9"
Top of pavement
Slope 1" in 10'-9"
8"B 30lb 5' long over ducts
1⅛" high tensile steel tierod
10"I-beam 25.4lb 20'c. to c.
Fresh air flue
Fresh air flue
Fresh air duct
Payment line for excavation

Fig. 4. **A multitude of service facilities, including the ventilation ducts, complicates the design and construction of the tunnel. This is a typical cross-section of the shield-driven section in river silt.**

as a first step only one tunnel and operate it for two-way traffic until funds were available for building the second tube.

Contract for the single tube was let in March, 1934, subsequently followed by contracts for the approaches, ventilation buildings and other facilities necessary to complete the first tunnel.

However, the financial situation changed for the better in 1935 and the Port Authority was able to sell in open market bonds amounting to $22,300,000 which the PWA agreed to purchase. Encouraged by these sales, the Authority, in December, 1935, released the PWA from its contractural obligation to purchase the remaining $15,200,000 of bonds in exchange for an outright grant, without loan, of $4,780,000. The bond market continued to improve, and late in 1936 the Port Authority was able to arrange for financing construction of the second tube of the project, which will complete the project as originally planned.

Contracts for the second tunnel were let last January, and construction work is just getting under way at this time. Meanwhile work on the first tube and its appurtenances has progressed rapidly. It is expected that this tunnel can be put into two-way service early in 1938. Completion of the second tube is expected late in 1940, when the project can be operated with double one-way roadways in each tunnel.

General plans

The general plans, as finally adopted, call for two parallel shield-driven tunnels from Manhattan to the foot of Kings Bluff on the New Jersey shore. The two tunnels continue in rock through the bluff, curving southward to emerge in a wide plaza at a point where the Palisades set back some distance from the river edge. Toll booths for both tunnels will be located at the New Jersey plaza. This plaza connects directly with Park Ave. and the Hudson County Boulevard in Weehawken, though it has been found necessary to relocate the Boulevard for 3,000 ft. to make way for the tunnel approach. A new roadway built by the Port Authority as part of the approach, loops to the east and north to the top of Kings Bluff. The plans call for extending this roadway westward through Weehawken, Union City and North Bergen in a deep cut to connect with main state highways to the west.

Plans for approaches on the New York side were complicated by the freight line of the New York Central R. R. which was then being rebuilt on a new location that runs in open cut below street level between Tenth

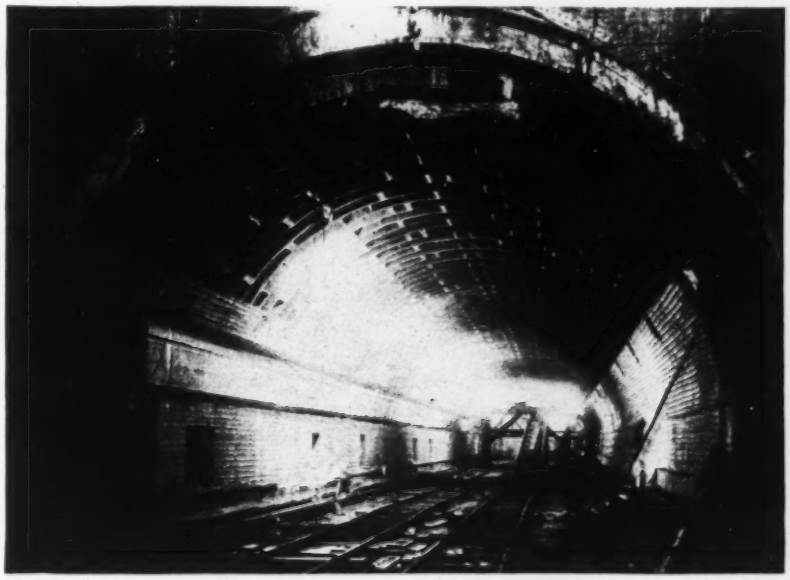


Fig. 5. **Construction of a subaqueous vehicle tunnel requires many operations. This view, looking westward from the New York caisson, shows the start of concrete lining work.**

and Eleventh Avenues north of 34th St. To distribute the tunnel traffic over as many streets as possible in a somewhat congested area, the entrance and exit plazas are to be separated. Traffic from the south tube (first of the two to be built) will emerge at the east side of Tenth Ave. to a triangular sunken plaza which occupies the west half of the block between 38th and 39th Sts. From this plaza new approach streets have been built in ramp cuts to 42nd St. on the north and 34th St. on the south. The south ramp will have direct connection with 34th, 35th and 36th Sts., the last two being locally depressed to meet the ramp grade. The north approach likewise connects with three cross streets, 40th, 41st and 42nd Sts., the first two being changed in grade. Overhead bridges have been built at 37th, 38th and 39th Sts. to carry these cross streets over the approach ramps. During the time of operation of the south tube under two-way traffic, the south approach will be used as exit only, and the north ramp for entrance. Subsequently both approaches will be used for exit only.

The entrance plaza for the north tube, which will be used for west bound traffic only, will be over the New York Central cut west of Tenth Ave., between 39th and 40 Sts. Approaches will be through new streets created by covering the railroad cut. The tunnel portal will be to the west or riverward of the railroad. Because of this separation of the plazas, the north tube will be somewhat shorter than the south one. In both cases provision is being made for fuure connections with the proposed cross town tunnel.

Ventilation will be taken care of by three ventilation buildings, one at the foot of Kings Bluff on the New Jersey side, one at the New York shore line, and one at Eleventh Ave. The latter will serve the New York land tunnels. The Jersey ventilation building rests on a deep shaft in rock; the New York shoreline building is founded on steel and concrete shafts sunk to rock by the pneumatic method.

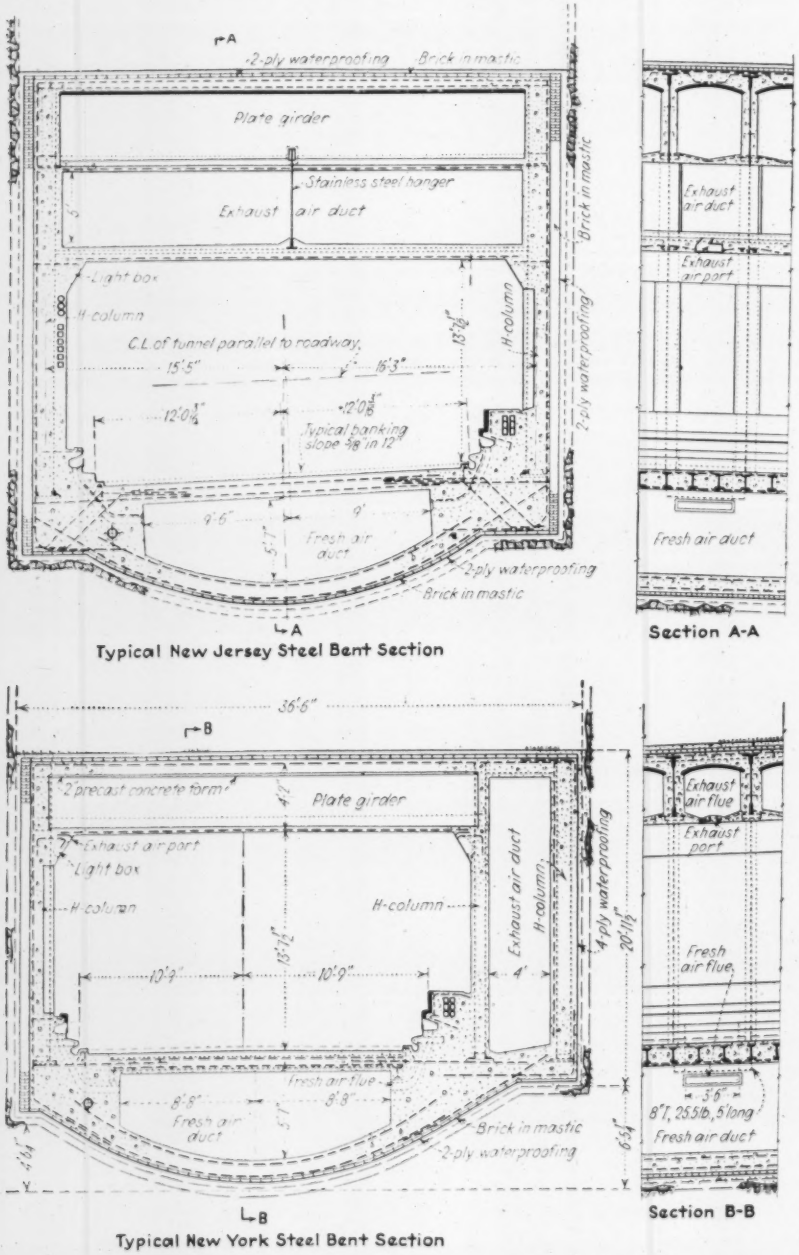


Fig. 6. Cut-and-cover sections at the extreme ends of the tunnels are of interesting design. Heavy overburden on the New Jersey end required unusually heavy columns and girders; shallow cover on the New York end necessitated placing the exhaust air ducts at the side.

Tunnels in rock and silt

From portal to portal the south tunnel is 8,976 ft. long, of which 5,978 ft. is shield driven, lined with cast iron segments, 1,237 ft. is circular rock tunnel lined with a new type structural steel lining, and the remaining 1,761 ft. is steel-bent construction built in cut-and-cover. The shield section extends from a construction shaft near Eleventh Ave., Manhattan, westward through the ventilation plant caisson and under the river to the New Jersey ventilation shaft, about 1,000 ft. beyond the river edge. The New York approach consists of 447 ft. of rock tunnel and 721 ft. of cut-and-cover, including 135 ft. of shaft excavation for the land ventilation plant. On the New Jersey side the approach includes 790 ft. of rock tunnel and 240 ft. of cut-and-cover.

The main portion of the shield section lies entirely in Hudson River silt, while at each end the soft ground tapers off into rock. Driving the shield through part rock and part silt was the most difficult job of the tunnel work. The extreme ends of the shield are in solid rock, though cast iron lining was carried from shaft to shaft.

A concrete cradle carried the shield through all rock sections.

The north tunnel, as previously noted, will be somewhat shorter. Details of the land approach section have not as yet been worked out as to exact length, but the construction shaft for the shield section is 318 ft. west of the corresponding shaft of the adjacent tunnel. Being on the outside of the long curve, the New Jersey land section of the north tunnel is somewhat longer, requiring 828 ft. of steel-lined rock tunnel and 330 ft. of open-cut steel-bent construction.

Tunnel design

The design of Lincoln Tunnel is similar to that of the Holland Tunnel, except the new tubes are 31 ft. outside diameter, 18 in. larger than the latter. This larger diameter permits a roadway 21½ ft. wide, as compared with the 20-ft. Holland Tunnel roadway. Ventilation space for fresh air below the roadway slab and for exhaust air above the ceiling slab is also larger. The roadway has a clear height of 13 ft. 7½ in. The new tunnel also differs from its predecessor in that stippled glass tile is to be used on the ceiling and de-aired vitrified brick for paving. This is the first use of glass tile for such purposes. An experimental section of brick paving has been in service for some time on an approach to the Holland Tunnel.

The shield-driven sections are lined throughout with rings of cast-iron or cast-steel segments, steel being used at points of high stress, such as at the mid-river sump, intersections of the tube and the ventilation shaft, and where the silt meets the rock. The lining rings, 30 in. wide, are made up of fourteen standard segments and a key, bolted up with 1¾x8¼-in. high tensile strength bolts. A total of 4,591 rings, weighing 102,240 tons is required for both tunnels, of which 6,040 tons is cast steel. Taper rings are provided for changes in grade and alignment. The lining weighs 21.95 tons per ring, or 8.75 tons per foot of tunnel. Details of the tunnel design are shown in Fig. 4. Tie rods through the floor will be omitted where the tunnel is in rock. A total of 673,000 bolts and nuts, and 1,346,000 cut washers, weighing 3,500 tons, is required for the iron lining.

Structural-steel lining

Specifications permit an alternate of an unusual type of structural steel lining to be used in the land tunnel sections that are located in rock in place of the standard cast-iron segments. The steel lining, because of its lower cost, has been adopted for all three land tunnels awarded to date. The lining is built up into rings similar to the iron rings, but twice as wide, eleven segments and a key making up a complete ring. Segments are 60 in. wide, 112.8 in. long on the outside arc, built up into pans 4½-in. deep of a ½-in. skin plate, ⅜-in. side and end plate, stiffened by two curved sections of split 16-in. H beams, flanges outstanding. The whole is fabricated into a rigid segment by continuous shop welds at all joints. Rings are erected by bolting through the side and end plates, and by bolting strap splices to the stiffeners to form continuous ribs. These splices

Fig. 7. Approaches form no small part of the tunnel project. Here is the New Jersey entrance plaza under construction, with the steel-bent sections in the left background. The shaft at the lower right corner is an air vent for the P.R.R. tunnels. A loop highway will be built from the lower end of the plaza, around this shaft and up the bluff at the right, crossing to the left over the boulevard. *Aerial Explorations Photo*

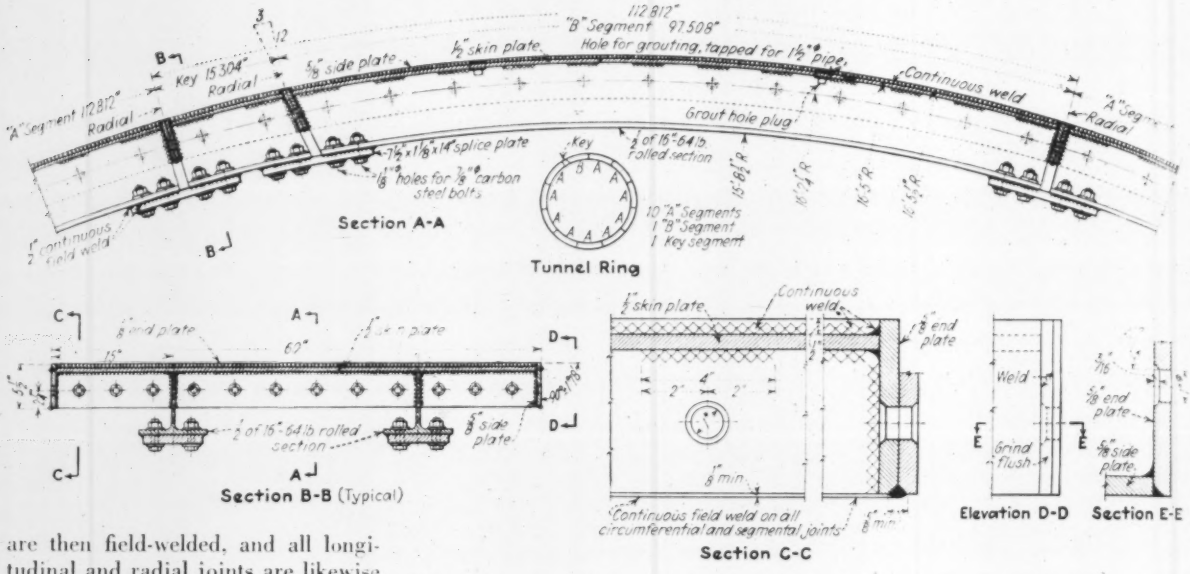


Fig. 8. Structural steel segments of a new type competed favorably with the standard cast-iron units for lining of the non-shield driven land tunnels.

are then field-welded, and all longitudinal and radial joints are likewise field welded after erection. Details of the new lining are shown in Fig. 8.

Interior details of the tunnel structure are the same for the structural steel sections as for the under-river cast iron portions.

The design of the structure in cut-and-cover sections is of interest. In general it is of steel-bent construction, bents 5 ft. center to center, with concrete roof and sidewalls. Steel floor beams carry the roadway, the same as in the tunnel sections, and below the floor is a curved invert to provide space for the fresh air supply. On the New Jersey end the columns vary from 14-in. 142-lb. to 33-in. 220-lb. rolled sections. Roof beams here are plate girders from 54 in. to 66 in. deep. Except for the portion near the portal, the open cut structure is built with a 5-ft. high open space between bottom of roof beams and ceiling slab of roadway, which is used as the exhaust air passage. As the structure approaches the portal the top air passage narrows in height, giving way to a rising arch ceiling in the roadway area.

Shallow cover on the New York land section dictated a somewhat different design. Here the roof girders, about 46 in. deep form the roof of the roadway, and the exhaust air duct is located in a high narrow chamber at the side of the structure. Exhaust air passes through ports in the ceiling slab into chambers between the roof girders, and thence into the main duct at the side. Fig. 6 shows typical cross sections of both designs.

LINCOLN TUNNEL — PRINCIPAL CONSTRUCTION CONTRACTS

Description	Contractor	Estimated Contract Price
Manufacture, storage and delivery of cast-iron and cast-steel tunnelling	Bethlehem Steel Co	$2,356,218
Manufacture, storage and delivery of bolts, nuts and washers for tunnel lining	Oliver Iron and Steel Corp.	178,486
Shield-driven tunnel and shafts (South tube)	Mason & Hanger Co., Inc	6,389,452
New Jersey rock tunnel section	Underpinning and Foundation Co., Inc	1,052,405
New Jersey land sections and plaza	Geo. M. Brewster & Son, Inc	2,654,053
New York land sections, plaza and approaches	Cornell Contracting Corp.	2,720,304
Fans, motors and transmissions	Buffalo Forge Co	180,230
Weehawken, plaza connections	George M. Brewster & Son, Inc	1,237,417
New York ventilation building	Cauldwell-Wingate Co	347,350
New Jersey ventilation building	George Siegler Co	526,516
Ceiling tile	MacBeth Evans Glass Co	161,000
New York land ventilation building	George Colon Contracting Corp	427,000
Electrical equipment and installation	J. Livingston & Co	948,366
Tunnel finish	Del Turco Bros., Inc	350,127
New York approach finish	P. J. Carlin Construction Co	471,000
Tunnel and plaza brick paving	W. J. Fitzgerald	134,987
Field office building	George Siegler Co	429,568
Manufacture and delivery of cast-iron and cast-steel tunnel lining (North tube)	Bethlehem Steel Co	3,080,252
Shield tunnel, rock tunnel section and shafts (North tube)	Mason & Hanger Co. Inc	8,764,003

The two caissons forming the base of the ventilation towers just off the New York shore line are steel and concrete structures 42ft.6in.x52ft.4in. in plan at the widest section. The south caisson is 100 ft. from cutting edge to top; the north box is 4 ft. shorter in height. The caissons are of steel-frame construction of ½-in. skin plate braced by horizontal encases in a 6 ft. concrete wall. Ring girders were built into the two sides of each box through which the shields enter and pass through the caissons. A permanent passage between the two caissons is provided by a 9-ft. tunnel driven at centerline of roadway area. The caissons land on rock bottom about 48 ft. below center of tunnel. From 25 ft. below water level to the top the shafts have an outside protection of concrete, which carries a granite facing at the water line. The caissons are of the pneumatic type. The second one is now being fabricated.

Ventilation equipment

A total of 55 fans having a combined capacity of 8,834,000 cu. ft. of air per min. will be required to ventilate the two tunnels. Part of the fans act as blowers for supply of fresh air; the others are exhaust units to pull out vitiated air. The blowers, 24 in all, have a total capacity of 4,578,000 c.f.m., while the 28 exhaust fans will withdraw 4,256,000 c.f.m. These are to be housed in three towers of

steel frame and concrete construction, faced with brick. The static pressure of the fan varies from 0.375 to 4.0 in. of water. Their individual capacity ranges from 105,000 to 280,000 c.f. of air per min.

Each unit of the New Jersey plant has six blowers and seven exhaust units, aggregating 1,134,000 and 1,-054,000 c.f.m., respectively. A blower capacity of 840,000 c.f.m., is divided among three fans in each unit of the New York river shaft, and each unit has four exhaust fan units of 740,000 c.f.m. capacity. At the New York land plant are six blowers aggregating 630,000 c.f.m., and six exhaust fans drawing 648,000 c.f.m.

Progress

The first major construction contract, that for the shield section of the south tunnel, including the New Jersey shaft and the caisson for the New York river ventilation shaft, was awarded in March, 1934. A contract for the cast iron lining had been let several months earlier. Contracts followed in rapid order for the New York land section, the New Jersey land tunnel, the west plaza and cut-and-cover sections, the ventilation buildings, equipment, New York plaza, tunnel lining and roadway paving. In record time the New Jersey shield was driven across the river, holing through into the New York caisson in August, 1935. The south tunnel will be ready for two-way operation about the first of next year. Contract for the north tunnel iron was let in December, 1936, and that for the shield tunnel in January, 1937, the last including the New Jersey land tunnel. The shields and shaft caisson for this tube will be ready in June. The contractor has already turned the heading on the land tunnel at the New Jersey shaft.

Construction work has been or is being carried out under the principal construction contracts shown in the accompanying table.

All design and construction work is being done by the Port of New York Authority, of which O. H. Ammann is chief engineer, E. W. Stearns is assistant chief engineer, Ralph Smillie is engineer of design, and James Forgie, Robert Ridgway and Ole Singbad are consulting engineers. O. S. Gleim is construction engineer.

Rubber Expansion Joint Used In Sewage Plant Blower Line

PROVISION for expansion and contraction of air blower lines at the new Easterly sewage disposal plant in Cleveland, Ohio, has been made by installing special rubber expansion joints which were designed and made by the F. Goodrich Co., Akron, Ohio. In addition to absorbing movement of the line, due to frequent thermal changes, use of these joints on the blower outlet prevents vibration from being transferred to the distribution line.

The blower units are capable of moving 170,000 cu.ft. of air per minute; the largest units have a capacity of 40,000 c.f.m. The intake line on each blower has a suction pressure of 10 in., water gage, and the outlet has a discharge pressure of 7½ lb.

In the accompanying photograph is shown an expansion joint installation between the blower outlet and distribution chamber. Also pictured is a group of rubber joints used in various parts of the system. The large joints are used on the outlet and the small ones on the intake line. The rubber is specially compounded for long aging qualities and resistance to continual flexing; extra strength is obtained through a two-ply cord fabric reinforcement. The joints used on the intake line have an added double wire reinforcement to enable them to withstand the collapsing pressure.

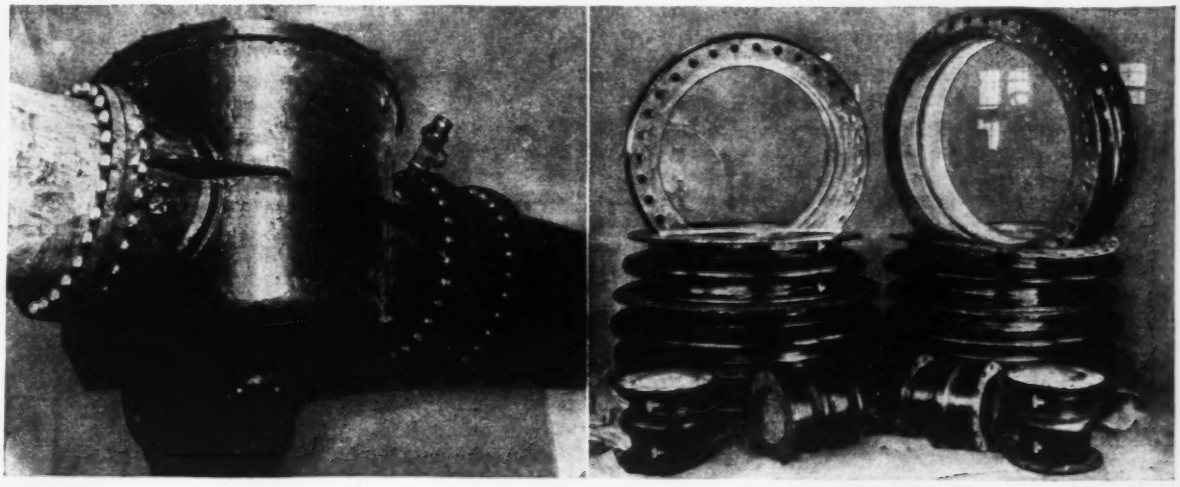


Fig. 1. Rubber expansion joint installation on the air blower line at the Easterly activated sludge sewage treatment plant in Cleveland. At the right is a group of the specially designed joints used in various parts of the air distribution

Water Supply Alternatives Confront City of San Diego

Importation of water from outside sources studied by city to supplement limited local supplies

THE dry climate of San Diego, Calif., may be a great asset in some respects but it presents problems to those responsible for developing the city's water supply in advance of the needs of an increasing population. Annual rainfall varies widely and major runoffs, on which dependence for a continuous water supply must be placed, may occur only at 10- or 11-year intervals. Thus cyclic storage is necessary. In recent years it has become apparent that even cyclic storage, with development of local sources to the utmost, will suffice for only a few years more and thereafter water must be imported from some outside source.

The only source available is the Colorado River. From that stream water could be had in two ways: (1) by joining the Metropolitan Water District of Southern California or (2) by bringing a supply through the All-American canal and pumping it over the mountains from Imperial Valley. Last year San Diego retained a consulting water board of three members to study these alternatives and make recommendations. The board consisted of Louis C. Hill and Lester S. Ready, consulting engineers, and J. P. Buwalda, consulting geologist. This board has reported in favor of the All-American canal plan and that recommendation now is being studied by the city. Some essentials of the report are abstracted in the following.

The report is based on needs of the San Diego metropolitan area including both domestic and irrigation requirements of some 630 sq.mi. This area now has a population (including the city's 175,000) of about 210,000, which, it is estimated, might increase to 590,000 by the year 2000. In this area as a whole the ultimate yield of local water sources fully developed on the cyclic-storage basis is about 87 m.g.d. The demand may be expected to reach this figure by 1950. Meantime, additional local storage should be developed by construction of dams in the following order: (1) Super-Hodges, (2) San Vicente, (3) Mission No. 2 and (4) enlargement of Barrett dam.

In considering the two possible means of additional supply it was found that water purchased from the Metropolitan Water District would travel a total of 296 miles in artificial conduit (218 miles in the aqueduct from Parker dam to west portal of San Jacinto tunnel, 59 miles in conduit built by the Metropolitan Water District and 19 miles in conduit built by the city of San Diego terminating in San Vicente dam). In this delivery system the total pump lift would be 1,616 ft. The total cost for the ultimate supply of 75 m.g.d. available to San Diego metropolitan area from this source would be $17,880,000.

If the city exercises its right to a flow of 155 sec.-ft. (100 m.g.d.) of Colorado River water that could be diverted for city use at Imperial dam, this supply could be brought through the All-American canal in return for payment of a share in the annual operating and amortization costs of that property. These payments, on 4 per cent interest and 40-year amortization, are estimated at $16,500 per year. This cost would cover the delivery of the water through about 134 miles of canal to the west side of Imperial Valley. From that point the city would have to build its own delivery system over the mountain to reservoirs on the coastal slope, a distance of 42 miles more. Included in this final part of the route would be a pump lift and a tunnel; the higher the pumping lift the shorter the tunnel. Economic balance is involved in weighing labor cost for driving the tunnel against power cost for pumping. Under present conditions, and assuming that the pumping would be done with offpeak power costing ½ cent per kw.-hr., the most economical plan was found to be a pump lift of 2,700 ft. and a tunnel length of 7.33 miles. This tunnel (San Felipe) is estimated to cost $2,700,000 and could be driven in about four years. There would be six pumping stations, each working against a head of 475 ft. On the basis of the ultimate development of 100 m.g.d. this delivery system would involve an annual cost of $2,866,000, which would make the water cost 7.85c. per thousand gallons.

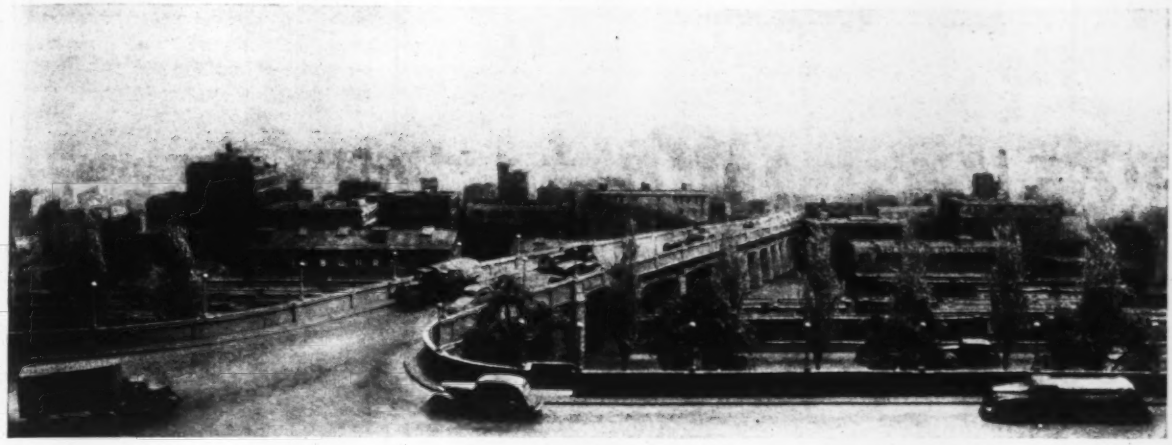
According to these estimates the capital cost of bringing in water via the All-American canal route would be $15,968,000 or almost $2,000,000 less than the capital cost of the plan involved in joining the Metropolitan Water District. In addition, the All-American canal route lends itself to step-by-step development and lower initial cost, particularly when combined with additional local development. The board accordingly recommended in favor of the All-American canal plan, advised the city to complete the contract with the U.S. Bureau of Reclamation, thereby securing the city's right to use of the canal, and to proceed with the development of all local storages.

Steady Rise in Lake Mead Caused by Spring Runoff

STORAGE in Lake Mead up to May 28 had reached 13,000,000 acre-ft., according to the Bureau of Reclamation. This provides a head of 428 ft. on the turbines of the power house or more than enough to insure the continuous production of the power now under contract.

Spring runoff from the mountains at the headwaters of the Colorado River is responsible for the steady rise in the lake which amounted to 1.8 ft. per day during the latter part of May. Nearly three million acre-ft. was added during May to the water impounded behind Boulder Dam, or at about the rate of 81,000 sec.-ft., which is a moderate flood flow. The peak spring flow, which results from melting snow in the Rocky Mountains, has not yet arrived. The lake behind the dam now is 105 miles long.

Contracts for Boulder Dam power went into full effect on June 1.



ARTERIAL HIGHWAYS MUST PROVIDE FREE MOVEMENT INTO THE HEART OF A CITY

A Master Plan for Highways

by FRANK T. SHEETS

Consulting Engineer, Portland Cement Association, Formerly Chief Highway Engineer of Illinois, Chicago, Ill.

The proposed master plan will cost 57½ billions but the saving in traffic cost will return the investment in 25 years and road users taxes now provide the funds needed for construction if all were used for road purposes

A master planner of the past, Daniel H. Burnham, said: "Make no little plans; they have no magic to stir men's blood." Boldly following this inspiring text the writer of the article that follows proposes a $57,500,000,000 master plan for roadbuilding for the United States. Let us look at the proposed plan and its probable balance sheet as they are given by the former chief engineer of highways of Illinois in the following condensation of his full argument before the Greater New York Safety Council.
—EDITOR

TOMORROW'S highway system is no longer an academic question; it looms directly ahead of road transport and if road transport expects to forge ahead in proportion to its present promise it must meet the situation boldly. The problems are many and some of them are uncertain, but one thing that is sure is that tomorrow's highway system must provide many classes of facilities, each correlated with all others in accordance with a basic plan, the integrated whole serving adequately, safely and economically transcontinental, intersectional, interstate, intercity, intercounty and local travel. What roads will such a system include?

System set forth

Terminal Highways—In metropolitan centers such as New York, Chicago, Boston, Philadelphia, Washington, St. Louis, Los Angeles, San Francisco and many others, there must be elevated or depressed limited ways to pick up traffic delivered at the edges of these congested areas and from other thoroughfares within the areas themselves, and move this traffic with safety and dispatch to the focal points. These major traffic arteries must have adequate traffic and safe-speed capacity, must have opposing traffic lanes separated, must be free from grade crossings either with railways or other highways and must have ramps for picking up and discharging traffic at strategic points.

Main Superhighways—Transcontinental and intersectional travel will demand the development of a limited mileage of superhighways permitting high-speed, safe travel between important population centers and between major sections of the United States. These highways will ultimately provide from four to eight traffic lanes, each 12 ft. wide, will have no grade crossings with highways or railways, will eliminate all pedestrian and horse-drawn traffic and will provide for egress and ingress of vehicular traffic at only fixed points several miles apart. Speed will be limited only by the capacity of driver and vehicle. Trucks and slower moving vehicles will be segregated into special lanes. Opposing traffic lanes will be separated. Alignment, grade, sight distance and superelevation should be predicated on top speeds of 100 mi. per hour. Free movement and discharge capacity should be encouraged rather than discouraged by arbitrary speed limitations and unwise policing. These highways will avoid all

cities and towns and will be freeways in all respects.

Main-Trunk Highways—Supplementing the main superhighways will be a larger system of main-trunk highways. These will feed traffic into the main superhighways and will serve other intercity, interstate and intersectional traffic. They will probably be divided into two groups:

1. Primary—Primary main-trunk highways will be improved to high standards of surface, grade, alignment, sight, distance and super-elevation. Traffic lanes will be from 10 to 12 ft. wide and where more than two lanes are needed, opposing lanes will be separated. Grade crossings will be provided at railways and important intersecting highways. Walkways will be provided for pedestrians. Wherever possible, these highways will avoid the built-up sections of cities and towns. Safety will be designed into these highways to permit cruising speeds up to 80 mi. per hour except where physical conditions require reduction. Safe speeds will be posted.

2. Secondary—Secondary main-trunk highways will supplement the primary main trunks and will round out the main highway system by serving intercity, interstate and intersectional travel which is important but not of major significance. On these roads, high standards of design and operation will be used, modified from the primary standards as conditions may warrant. In open country, the safe speed should be 60 mi. per hour.

Intermediate Highways—These highways will include those which serve mainly the traffic between local communities but carry also some interstate or intersectional travel. They will include the main county and main farm-to-market roads or roads reaching into neighborhoods. Obviously they will not require the high standards of design and load capacity which must be built into main trunks. But even these roads will require for safe and economical operation a much higher degree of improvement than they now enjoy. Stable surfaces, two traffic lanes of at least 9 ft. each, adequate shoulders, and standards of alignment, grade, sight distance and super-elevation compatible with maximum operating speeds of 50 or 60 mi. per hour in open country should be employed. Where lower speeds are required by conditions, the safe limit should be posted.

Land-Service Roads—These will include the vast mileage of low-traffic rural roads whose primary function will be to give access to land. They will never require high standards of surface, alignment, grade or sight distance, but the American farmer will never be satisfied until these roads have placed on them some cheap form of all-weather, stable surface.

Bypasses and Belt Lines—Included in tomorrow's highway system will be bypasses or belt lines around all sizeable urban communities on main trunk highways. These facilities will be absolutely essential to the proper and safe use of main-trunk highways. Likewise, by keeping through traffic out of congested urban centers they will offer the most reasonable insurance of convenience, peace of mind and efficiency in conducting normal business and social affairs within these communities.

Arterial Streets—Regardless of belt lines and bypasses, there will be need of improvement of arterial urban streets which will carry into and through the cities and towns, that part of rural main-trunk traffic which has business within the urban area. These urban routes must have adequate width, smooth, stable surfaces and proper facilities for traffic control. There will also be other arterial streets or boulevards onto which local street traffic naturally gravitates. These must likewise be adequately improved for the general good.

Land-Service Streets—Comparable to land-service roads are the local and residential streets which give access to urban property. Their improvement cannot be dodged.

What will be the cost?

The question naturally arises: What will all this cost? Data are not available for making accurate estimates, but some general figures may be helpful in visualizing the problem ahead. There are about 3,000,000 mi. of rural highways in the United States. Traffic surveys which have been conducted indicate that this mileage may be broken down into the major groups and with these figures as a basis, Table I shows a reasonable estimate of the additional investment which may ultimately be required to realize the highway system of tomorrow.

TABLE I—HIGHWAY MILEAGE AND SERVICE AND COST OF THE IMPROVEMENT ACCORDING TO THE MASTER PLAN

Class of Highway		Miles	Per Cent of Traffic Carried	Additional Investment per Mile $	Approximate Cost $
Main Trunks	Super-highways	60,000	66	300,000	18,000,000,000
	Primary	150,000		50,000	7,500,000,000
	Secondary	90,000		35,000	3,150,000,000
Intermediate		600,000	25	20,000	12,000,000,000
Land Service		2,100,000	9	5,000	10,500,000,000
Total		3,000,000	100	.....	51,150,000,000
Terminal facilities, arterial streets and belt lines		.....	.....	.....	5,850,000,000
Total		.....	.....	.....	57,000,000,000

Note.—The above table does not include local or land service city streets.

TABLE II—VEHICLE MILES OF TRAVEL AS SHOWN BY SURVEY IN FIVE STATES

State	Year	Vehicle Miles of Travel	On Urban Streets	On Rural Highways
New York	1932	19,472,700,000	12,214,300,000	7,258,400,000
Michigan	1931	9,720,117,000	4,830,363,000	4,889,764,000
Minnesota	1932	5,131,700,000	2,099,300,000	3,032,400,000
Wisconsin	1930	5,996,956,000	2,151,230,000	3,845,726,000
Illinois	1931	14,178,270,000	7,995,784,000	6,182,486,000
Totals	.....	54,499,743,000	29,290,977,000	25,208,766,000
Per Cent	.....	100	53.7	46.3

TABLE III—SAVING 2 CENTS A VEHICLE MILE WILL RETURN INVESTMENT FOR MASTER-PLAN ROAD SYSTEM IN ABOUT 25 YEARS

Class of Highway	Percentage of Total Mileage	Miles	Per Cent	Rural Traffic Carried in 1935 (Estimated) Vehicle Miles	Saving in Car Operation at 2c per v. m. $	Proposed Expenditure for Highway Improvement. (See Table I)	Years Required to Save Expenditure
Main Trunk	10	300,000	66	68,600,000,000	1,372,000,000	28,650,000,000	20.9
Intermediate	20	600,000	25	26,000,000,000	520,000,000	12,000,000,000	23.0
Land Service	70	2,100,000	9	9,400,000,000	188,000,000	10,500,000,000	56.0
Totals and averages	100	3,000,000	100	104,000,000,000	2,080,000,000	51,150,000,000	24.6

The totals are enormous, but no less courageous view of the future will insure the broad conceptions and fundamental planning which are essential to the direction of each year's work toward a realization of the ultimate objective. A master highway plan for the United States, of which each state and city plan shall be a component part, is the best insurance of adequate and safe highway transport tomorrow.

Naturally the question arises—Can such huge highway expenditures be justified? Let us review the possibilities.

Highway transport surveys conducted in several states show the vehicle miles of travel given in Table II. According to figures published by the Bureau of Public Roads, the total gasoline consumed for highway travel in these states for the same years was 3,930,823,000 gal. This gives us 54,499,743,000 ÷ 3,930,823,000 = 13.865 vehicle miles of travel per gallon of gasoline.

In 1935, also according to bureau figures, there was consumed in the United States for highway travel 16,264,961,000 gal. or about 618 gal. per motor vehicle. Then total vehicle miles of travel in the United States for 1935 may be estimated as 16,264,961,000 × 13.865 = 225,500,000,000 (225½ billion). If we divide this into rural and urban travel by using the average percentages in Table I we get 225,500,000 × 0.463 = 104,000,000,000 vehicle miles of travel on rural highways.

Various authorities agree that adequate versus inadequate highway improvement will effect a saving of at least 2 c. per vehicle mile of travel. Applying this saving of 2 c. per mile to the vehicle miles of rural travel in 1935 we get an annual saving of $2,080,000,000 which would, in about 25 years amount to the investment for rural highways.

But if we break down the 1935 rural traffic by road classes using the percentages from Table I we get Table III. An analysis of this table indicates that even on the basis of present highway use, the extensive future rural road program is justified. More-adequate highways will bring more use of highways by the present number of car owners and will induce more people to buy new vehicles. This will increase the total miles traveled and increase the savings which highways bring. The normal increase in population will have a similar effect.

Can we get the money?

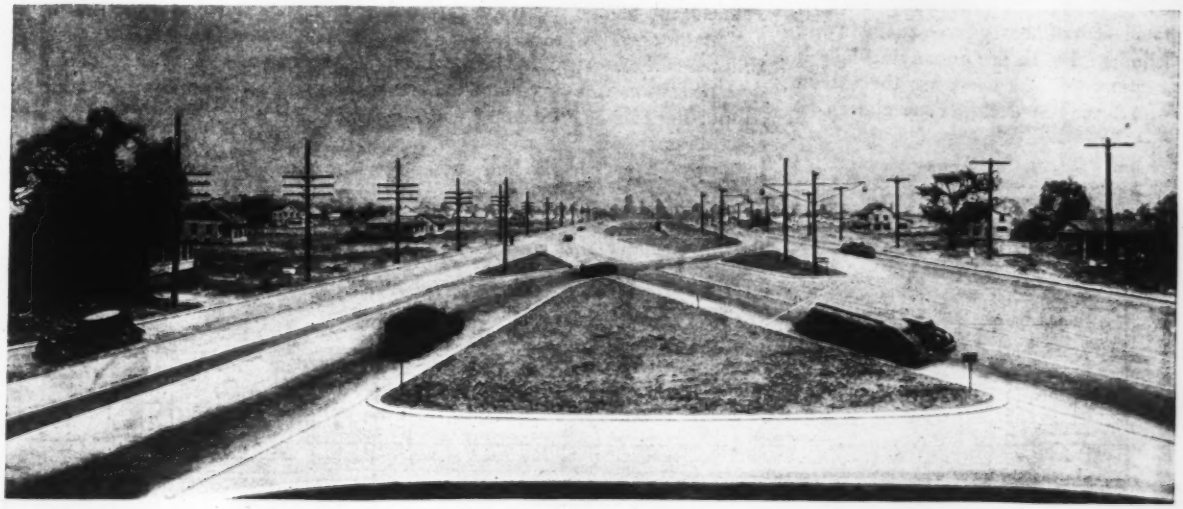
We are now collecting in motor imposts (license fees, miscellaneous fees and motor fuel taxes) about one billion dollars a year ($942,454,002 in 1935).

With the increased highway use which will inevitably follow provision of adequate facilities, it is conservative to estimate that even the present rates of motor imposts will yield an average of 1½ billions of dollars per annum during the next generation. Reserving ½ billion for maintenance, operation, administration and other fixed charges, this should make available 1 billion dollars a year for new improvements.

The federal government will realize so many benefits in increased commerce, potential military use and in the postal service, that an annual contribution of $250,000,000 from that source would be fully warranted.

These combined construction funds would be 1¼ billions per year. A reasonable ultimate expenditure for the facilities properly chargeable to these funds would be 46½ billions of dollars. Hence we may reasonably anticipate that in about 37 years we could raise all the needed funds without increased taxation. A slightly higher rate would speed realization.

Such a program of general highway improvement would free local direct highway taxes for use in providing other facilities. These funds can be economically justified for use in completing the program of land-service facilities. The latest figures available show an annual collection of about $500,000,000 per year in local taxes for rural roads. About one half was spent for construction and one half for maintenance. With proper efficiency practiced in local expenditure and with local-road burden constantly becoming lighter, these local revenues should yield $400,000,000 annually for construction. This would permit progressive improvement of rural land-service roads and completion of the 10½-billion dollar program in about 26 years.



CONVERGING ROUTES MUST BE INTEGRATED WITHOUT LOSS OF TRAFFIC CAPACITY

Self-Anchored Eyebar Cable Bridge

by CONDE B. MCCULLOUGH AND RAYMOND ARCHIBALD

U. S. Bureau of Public Roads, San Jose, Costa Rica

Rio Tamasulapa crossing on the Pan-American Highway in Guatemala is effected by a suspension bridge of 240-ft. main span in which interesting Mayan architectural details are incorporated

OF THE THREE major bridges for the Inter-American highway, in the co-operative program between the United States government and the Central American governments, the one over the Rio Tamasulapa in Guatemala is the last to be placed under construction. Like the Rio Chiriqui bridge in Panama (*ENR*, Nov. 26, 1936, p. 757) and the Rio Choluteca bridge in Honduras (*ENR*, Jan. 21, 1937, p. 87), it is of suspension type. But here the similarity ends, for the Rio Tamasulapa bridge utilizes eyebars for cables instead of wire strands, and it is of self-anchored type. Furthermore it is the most unusual of the three bridges in architectural treatment, a definite Mayan motif being employed in the towers and railings.

The name Tamasulapa is of Mayoid origin, "Tamazul" signifying toad and "apan" water. This "River of Toads" is a peaceful enough stream during the dry season but is swollen to a width of nearly three quarters of a kilometer, with accompanying high current velocities, during the season of rains. The design type chosen to meet this condition is shown in the accompanying drawing. It is a self-anchored eyebar-cable suspension structure of 240 ft. main span and 100 ft. flanking backstay spans in which the horizontal tension component is taken by the bottom chord of the stiffening truss, which consists of two 15-in. 40-lb. channels and two 16x5/16-in. plates. The stiffening truss is continuous, the bottom chord being rigidly fastened to the towers, one of which rests on a roller nest to provide for free horizontal movement. The roadway width is 20 ft. clear, and no facilities are provided for pedestrian traffic, since the location is far removed from villages. Walkways can be added outside the trusses if they should ever be required.

Foundations

The piers and abutments of the Rio Tamasulapa bridge rest upon a foundation of steel H-beam piling. The abutments have straight back-wings designed as cantilevers but with one supporting pile at each outer end for erection purposes. The original design load was 40 tons per pile but, owing to the disclosure, during construction, of soft pockets not brought to light in the preliminary foundation exploration, it was found impossible to secure this bearing. To avoid the delay incident to ordering additional steel piles, the foundation resistance was augmented by the employment of timber piling.

Design factors

A standard H-15 loading was employed in the design. The eyebar chain system, including the pins, is of heat-treated structural carbon steel having an elongation in 18 ft. of not less than 80,000 lb. per sq. in., a yield point of not less than 50,000 lb. per sq. in., and an elongation in 18 ft. of not less than 8 per cent. For the chord system of the stiffening trusses and for the floor system silicon steel having equivalent physical properties was used. All other metal is standard structural carbon steel.

The design employed a basic unit stress in tension of 18,000 lb. per sq. in. for carbon steel and 25,000 lb. per sq. in. for silicon steel and heat treated carbon steel. The stresses were increased 25 per cent for (a) dead load plus live load plus impact plus temperature and (b) dead load plus *half* live load plus impact plus temperature plus *wind*. For the stiffening truss system these stresses were further increased by 10 per cent.

The architectural treatment of the

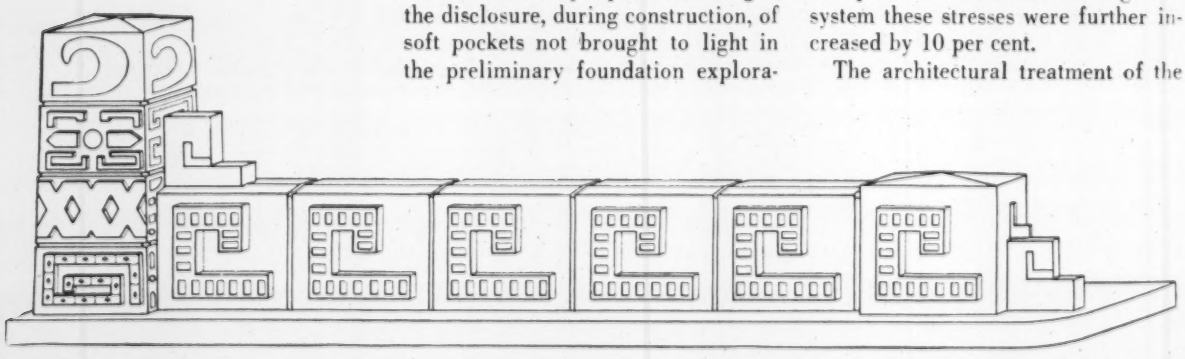


Fig. 1. Mayan designs on concrete pylons and railing of approach to Rio Tamasulapa bridge in Guatemala.

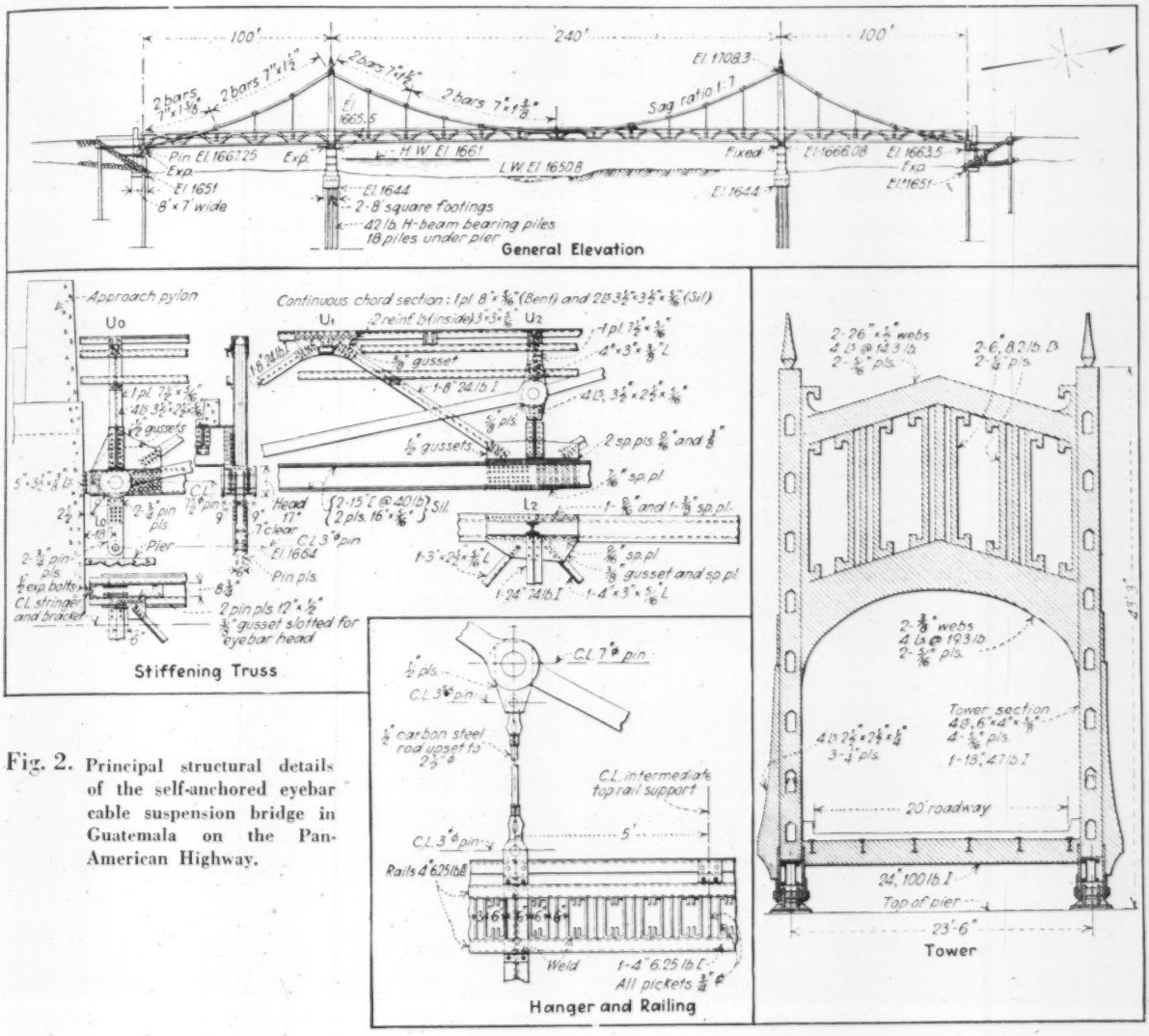


Fig. 2. Principal structural details of the self-anchored eyebar cable suspension bridge in Guatemala on the Pan-American Highway.

Rio Tamasulapa bridge is unusual but logical. Guatemala is the very heart of the Mayan "Old Empire". One of the earliest Mayan cities was Uaxaxtun in the Peten district of Northern Guatemala. According to the Spinden correlation, this city, and its sister city Tikal, were in the full swing of their glory as early as 200 to 300 A.D., and boasted a population of a million people or more. The southernmost outpost was C o p a n in northern Honduras, while in the west was the great city of Palenque near the present Guatemala-Mexico frontier. Within this great triangle scores, perhaps hundreds, of Mayan cities rose and flourished. The Mayan influence is felt through modern Guatemala, its presence is everywhere, its background her proudest heritage. It seemed, therefore, fitting to strike the Mayan note, even if faintly, in the treatment of the bridge.

The tower design carries the Mayan motif through the outline of its top strut and intermediate upper columns; the "folded-back" terminals being reminiscent of the conventionized "serpent's jaws"—a sculptural motif that persists with unusual frequency throughout the entire area of "Old Empire" building. This same motif was employed in the design of the steel handrailing in the pickets or spindles (Fig. 2). and also in the concrete hand railing, and was further applied by introducing in relief work on the entrance pylons certain of the variations and elaborations encountered in the embellishments of the Mayan structures.

The work on the bridge is being done co-operatively with the Republic of Guatemala by the U. S. Bureau of Public Roads uder the general direction of Thos. H. MacDonald, chief, and under the immediate direction of E. W. James, chief of the division of highway transport. D. Tucker Brown is in charge of all operations in Central America, and the writers are in charge of the bridge work.

The U. S. Steel Products Co., New York, has the contract for the superstructure, erection of which was begun about the middle of February. The substructure is being built on a day labor basis by the Republic of Guatemala under the direction of Sr. Don Carlos Bickford, assistant director general of roads. A. K. Haxstun is resident engineer and Sr. Don Guillermo Valenzuela, assistant resident engineer on the work for the U. S. government.

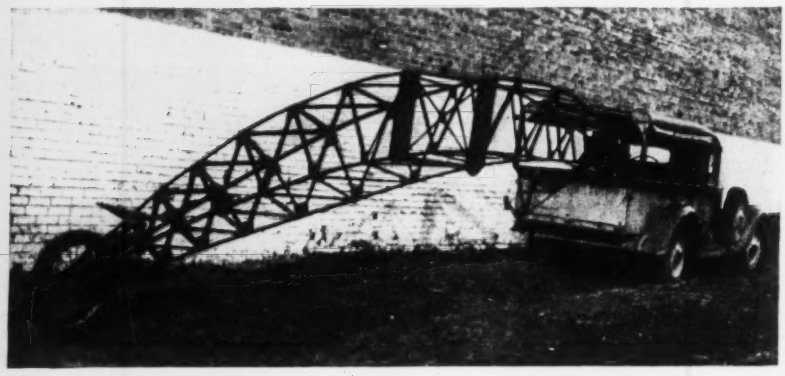


FIG. 1. TRAILER ARM THAT REGISTERS THE DEGREE OF CURVATURE

Curves Inventoried in Route

by J. M. DEBARDELEBEN

Associate Highway Engineer, Bureau of Public Roads, Little Rock, Ark.

Special truck gives location, arc, superelevation and grade of curves on 100 mi. of road daily

A SIMPLE trailer arm hitched to a truck has been found highly efficient in measuring curves in the inventory of Arkansas highways being conducted in cooperation with the Bureau of Public Roads. In addition to degree of curvature all superelevation or lack of superelevation and all grades in excess of 5 per cent were measured by clinometers fastened inside the cab of the truck, one graduated to read superelevation in inches and the other to read grade in per cent. These clinometers are small glass tubes, 14 in. long, bent to a radius of 30 in., patterned after the LeRoy clinometers originated by the Pennsylvania survey.

Degree of curvature, superelevation and grades were measured at least once each day by tape or tape and level as a check on the accuracy of the recording devices. A continuous log was kept of each highway maintenance section so that the data recorded could be easily correlated to other records.

Accurate reading to the nearest half degree was required in measuring the curves and to ensure this a study of the fundamentals was made, and it was decided that the factor limiting accuracy was the length of chord used in the measurement of the curve. Other apparatus had been designed by various states utilizing the chord length of an automobile, which amounted to one-half of an 18-ft. chord. It was decided that to obtain the desired accuracy, it would be necessary to use one-half of a 50-ft. chord or a wheel base of 25 ft. Accordingly, a 25-ft., one-wheeled trailer was used, as shown by Fig. 1.

The trailer is constructed of aluminum to eliminate unnecessary weight; is built in the form of a truss to obtain rigidity and is an arch to provide clearance over humps in the road. A single motorcycle wheel supports the rear of the trailer and a light pick-up truck carries the front end. The axle of the motorcycle wheel is maintained perpendicular to the axis of the truss by four set screws, so that the trailer will follow the truck accurately.

Fig. 2. Dial that shows the degree of arc as it is seen from the driver's seat in the truck.

As the trailer travels along the highway around curves, an angle is thrown into the connection between the trailer and the truck. This angle is stepped up by means of a 9 to 1 gear arrangement and a large dial 3 ft. in diameter calibrated to the nearest 15 min. and easily read from the front seat of the truck (Fig. 2).

To eliminate slack or play the connection of the trailer to the truck is made by four beveled studs, which insure no play.

Many improvements can be made on this apparatus, but a recent test run shows its present accuracy. The test run aggregated 26 miles, including 58 curves, and the following errors in measurement were found after a check with a steel tape:

32 curves or 55 per cent—No error from actual
14 curves or 24 per cent—15 min. error from actual
11 curves or 19 per cent—30 min. error from actual
1 curve or 2 per cent—45 min. error from actual

The above test shows that 98 per cent of the time the curves recorded by this device will be within 30 min. of the actual degree of the curve, and that 79 per cent of the time the error would not exceed 15 min. It is believed that after correction of certain difficulties known to exist, a mechanical accuracy can be obtained of 10 min. for 90 per cent of the time and that no measurement will be more than 30 min. in error.

At the time of this writing the apparatus had been operating 38 working days and had covered 3,931 mi. or an average of 103.4 mi. per day. Some additional survey information is being obtained by the party which slightly retards the progress, but quite a few days show well over 150 mi. of inventory. About 40c. per mile will be the total cost.

Safety devices consist of a red flag on the rear of the trailer and red lights at the rear and at the top and side near the center. The truck is equipped with a siren to warn passing vehicles when necessary. In making long jumps or dead hauls where no measurements are to be taken, an arrangement is provided whereby the trailer can be entirely supported on two brackets on the top of the truck. Fred J. Herring is manager of the statewide highway planning survey.

FIG. 1. TARRING THE BOTTOM LAYER IS IN PROGRESS ON THE SECTION OF HIGHWAY HERE SHOWN

Firming Fine Soil With Tar

by T. V. FAHNESTOCK

Bituminous Engineer, North Carolina State Highway and Public Works Commission, Raleigh, N. C.

A North Carolina road grade of soil too fine to stand up is made firm by bonding and sealing it with tar by two methods

In roadbuilding, soil stabilization finds its most difficult application in bonding and sealing fine soils. The case described in the article that follows is an example. The full tabulation of particle size and gradation and soil characteristics is given to emphasize the persistence of soil fineness and other qualities affecting water action. The degree to which waterproofing action was secured is also tabulated in full. These data are the vital elements of a story of constructive experimentation that comes from the North Carolina highway department. Among details the sandwich section is of unusual interest. —EDITOR

THE time is at hand when the available road funds in North Carolina will not meet the demand for surfaced roads, even using the relatively inexpensive types of bases constructed from local materials secured within a reasonable distance of the project. In searching for a resort to meet this situation several experimental sections of road have been constructed in which the material in the road, after proving definitely unsuitable for a base, has been waterproofed and stabilized by the use of bituminous materials.

Surry County experiment

One such experiment which offers several novel ideas was conducted on U. S. Route 601, Surry County, in the late summer of 1936. The road has an average daily traffic of 600 vehicles, about 20 per cent of which are heavy trucks and busses, and is in the foothills of the Blue Ridge Mountains where the average temperature range is from —5 to 100 deg. F., and the average precipitation is about 47 in.

The road was graded and surfaced with 6 in. of local topsoil (natural sand-clay) in the early twenties, and a bituminous surface treatment was applied in 1927. The surface treatment held up reasonably well until the winter of 1935–36, when the unusually severe weather caused it to fail completely, due to the lack of stability in the topsoil base.

The subgrade is composed of a fairly plastic red clay and is considered satisfactory as a subgrade material. The topsoil is reddish gray in color and is not a satisfactory material to be used as a base for surface treatment, due to excessive clay and silt content and poor physical characteristics. Results of tests made on the subgrade and the topsoil base are shown in Table I.

The section selected for the experiment was one mile long and was typical of conditions in this section of the state. On other portions of the road where the surface treatment failed the topsoil base was stabilized by mixing sufficient coarse sand with it to improve the grading and to overcome the undesirable physical characteristics. This reconditioned base was then compacted and surface treated.

The purpose of the experiment was to ascertain if a base which had

TABLE I — PARTICLE SIZE AND GRADUATION AND SOIL CHARACTERISTICS OF BASE COURSE AND SUBGRADE

Location	Particles larger than 2.0 mm	Soil Mortar — 100% Coarse Sand 2.0 to 0.25 mm	Fine Sand 0.25 to 0.05 mm	Silt 0.05 to 0.005	Clay smaller than 0.005 mm	Colloids smaller than 0.001 mm	Passing #40 sieve	Phys. Characteristics of Material Pass. #40 Liquid Limit	Plast Index	Shrinkage Limit	Shrinkage Ratio	Ft. Moisture Eq.
Sta.						Topsoil Base Course						
0+25	35	21	31	18	30	21	85	33	7	21	1.7	24
5+00	32	21	33	20	26	18	85	30	5	21	1.7	23
10+00	31	17	30	23	34	23	88	36	9	19	1.7	26
15+00	44	19	33	19	29	16	87	32	4	22	1.7	26
20+00	34	18	32	20	30	17	89	32	7	19	1.7	22
25+00	38	20	32	23	25	15	88	27	4	19	1.7	22
30+00	41	19	28	23	30	20	87	30	6	18	1.7	24
35+00	37	17	29	22	32	19	88	32	8	18	1.7	24
40+00	46	17	37	20	26	15	88	26	6	16	1.8	20
45+00	40	16	35	21	28	18	89	27	6	16	1.8	22
50+00	39	14	38	23	25	16	90	25	6	14	1.8	19
52+00	38	14	40	20	26	18	90	27	6	16	1.8	20
						Subgrade						
0+25	35	19	27	23	31	22	85	33	6	20	1.7	27
5+00	13	13	24	20	43	30	91	48	16	22	1.7	29
10+00	8	10	24	22	44	33	93	57	19	25	1.6	33
15+00	25	18	33	22	27	16	88	38	6	27	1.6	29
20+00	9	11	23	19	47	35	92	52	18	24	1.6	32
25+00	18	17	32	19	32	23	90	39	11	22	1.7	29
30+00	12	16	30	19	35	25	90	45	12	23	1.6	30
35+00	17	15	34	18	33	20	90	34	7	23	1.7	24
40+00	6	11	28	16	45	35	93	47	18	22	1.7	23
45+00	27	11	27	15	47	35	93	49	19	23	1.6	33
50+00	27	18	34	15	33	22	87	37	12	18	1.7	24
52+00	15	8	24	17	51	41	95	66	24	25	1.5	40

TABLE II — MOISTURE CONTENT OF UNTREATED SOIL CORE ON PART 2 OF TEST SECTION OF ROAD

Date	Sept. 17–36			Oct. 7–36			Oct. 17–36			Nov. 4–36			Nov. 14–36			Jan. 9–37			Feb. 25–37		
Location	Lt.	C.	Rt.	Lt.	C.	Rt.	Lt.	C.	Rt.	Lt.	C.	Rt.	Lt.	C.	Rt.	Lt.	C.	Rt.	Lt.	C.	Rt.
Per cent of Moisture at Sta. 28	10	10	12	11	12	12	11	12	11	12	14	12	12	13	14	15	15	12	13	12	12
Per cent of Moisture at Sta. 38	8	8	8	11	10	10	10	9	9	8	9	9	11	9	8	13	11	16	17	13	12
Per cent of Moisture at Sta. 51	8	10	9	11	11	10	10	11	11	10	12	10	10	13	10	14	13	12	14	15	13

proved inadequate could be stabilized and waterproofed by the use of bituminous material so that it would render satisfactory service.

The section was divided into two parts: Part No. 1 (Sta. 0 to Sta. 26+40) consisted of a high-moisture tar mix having a compacted thickness of 4 in., while Part No. 2 (Sta. 26+40 to Sta. 52+80) was of a sandwich type, having a compacted thickness of 7 in. and consisting of a 5-in. untreated soil core between two 1-in. layers of high-moisture tar mix. Both parts were given a wearing surface of tar and ½-in. stone chips. The two sections are shown by Fig. 2.

Building Part No. 1

The existing road was scarified for a depth of 4 in. and the soil bladed to the sides. Tests showed a moisture content of 8 per cent in the soil, so water was applied as the material was bladed back into the road, a moisture content of 15 per cent being desired before starting the application of tar. The optimum moisture content of this soil was found to be 13 per cent but the additional moisture was required to compensate for evaporation during the mixing operations. It may be noted that rain occurred before and during the application of the tar, but the moisture content was maintained reasonably close to the desired 15 per cent.

Coal tar having a specific viscosity (Engler) of from 26 to 36 at 122 deg. F. was applied with a distributor until the following amounts per square yard had been placed:

Sta. 0 to Sta. 8 + 50 — 1.40 gal.
Sta. 8 + 50 to Sta. 17 + 45 — 2.00 gal.
Sta. 17 + 45 to Sta. 26 + 40 — 2.30 gal.

The variation in quantity was made to determine, if possible, the amount of tar necessary to give a waterproof stable base.

The tar was applied in increments of 0.2 to 0.25 gal. per sq.yd. and each application was mixed with a disc harrow. After the total quantity had been applied the mixing was completed with a blade grader and motor graders. As soon as mixing was completed the material was shaped and compacted by rolling, first with loaded trucks, then with a 5-ton roller. The compacted base was allowed to stand for 36 hours then the wearing surface was applied; this consisted of 0.22 gal. of the same grade of tar as was used in the base, covered with 20 lb. of ½ in. granite chips per square yard. This was rolled and given a

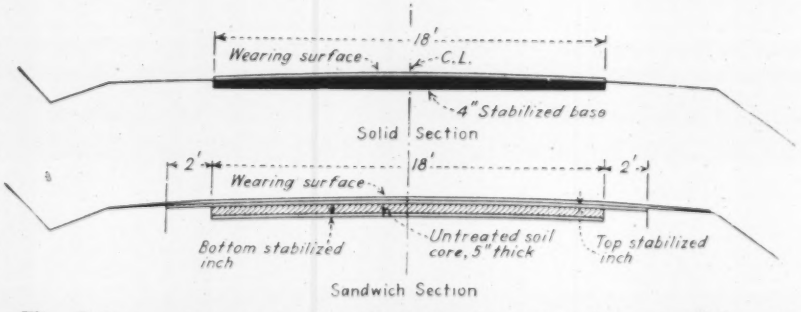


Fig. 2. Base sections tried out on North Carolina test road constructed last year were of two types, solid and sandwich stabilized-soil.

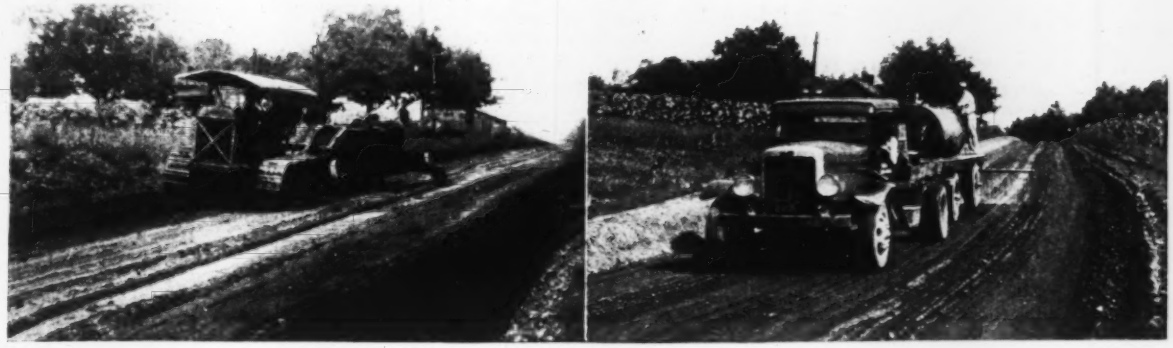


Fig. 3. In sandwich construction the scarified soil is bladed to the roadsides (left) to tar the bottom layer (see Fig. 1) after it is wetted (right) to 15 per cent moisture.

Fig. 4. The texture of the surface produced by spreading chipstone in advance of the final rolling.

second application of 0.22 gal. of tar and 12 lb. of chips. Immediately upon rolling traffic was permitted to use the road.

Observation of this portion of the experiment indicates no noticeable difference in appearance or behavior where the quantity of tar in the base was varied.

Building sandwich section

On Part. No. 2 the existing road was scarified for a depth of 6 in. and for a width of 18 ft., the soil being bladed to the sides. Then an additional 1 in. of subgrade was scarified and pulverized, after which water was added to increase the moisture content from 10 per cent to the desired 15 per cent. Tar was applied and mixed with the wet soil in the following amounts per square yard.

Sta. 26 + 40 to Sta. 35 + 00 — 0.77 gal.
Sta. 35 + 00 to Sta. 44 + 00 — 0.90 gal.
Sta. 44 + 00 to Sta. 52 + 80 — 1.01 gal.

After the mixing has been completed the mix was spread and rolled with

TABLE III — MOISTURE CONTENT OF UNTREATED SOIL CORE AND SUBGRADE ON PART 2 OF TEST SECTION OF ROAD.

Date		March 13-37		
Location		Lt.	C.	Rt.
Per cent of Moisture at Sta. 28	Core	14	12	12
	Subgrade	17	17	13
Per cent of Moisture at Sta. 38	Core	14	11	10
	Subgrade	24	19	10
Per cent of Moisture at Sta. 51	Core	12	10	12
	Subgrade	28	18	20

trucks and a 5-ton roller. As soon as the stabilized layer had been thoroughly compacted the soil which had been windrowed on each shoulder was bladed into the road in layers about 1 in. thick, and water was added and mixed with each layer to bring the moisture content up to the optimum. As soon as each layer was thoroughly mixed it was spread and compacted by rolling with trucks and a 5-ton roller. This rolling was extended out onto the shoulders for a width of 3 ft. on each side.

When all of the soil had been wetted and compacted the surface was harrowed for a depth of 1 in. and tar was applied in the following quantities per square yard.

Sta. 26 + 40 to Sta. 35 + 00 — 0.69 gal.
Sta. 35 + 00 to Sta. 44 + 00 — 0.84 gal.
Sta. 44 + 00 to Sta. 52 + 80 — 0.97 gal.

As soon as the tar was mixed with the soil the mix was spread for a width of 22 ft. and compacted by the same method as was used on the bottom inch. The top stabilized layer thus provided a roof over the untreated soil core that extended out

Fig. 5. Rolling finishes both tarred layers; the untreated sandwich filling and the final tar and chipstone surfacing are also well rolled giving the surface texture shown in Fig. 4.

onto the shoulders for 2 ft. on each side.

On the following day a prime consisting of 0.27 gal. of tar, 8 to 13 viscosity, was applied and allowed to penetrate for 24 hours before the wearing surface was applied. The wearing surface consisted of an application of 0.27 gal. of tar, 26 to 36 viscosity, covered with 20 lb. of ½-in. granite chips per square yard. From Sta. 39 + 60 to Sta. 52 + 80 an additional application of 0.20 gal. of tar and 12 lb. of chips was placed.

Results as observed

Work on the project was completed on Sept. 14, 1936, and since that time moisture tests have been made at intervals on samples taken from the untreated earth core. Results of these tests are shown in Tables II and III and are interesting in showing that while the moisture content in the untreated core increased some during the winter, this increase was in no case sufficient to cause the base to become unstable and also as shown in Table III it was considerably less than the subgrade moisture content.

An inspection of the project in March 1937 showed Part No. 1 to be in excellent condition. Part No. 2 was also good; however, some cracking was noted from Sta. 44 to Sta. 52+80; this section showed surface cracks and was somewhat soft. It is believed that both of these conditions result from an excess of tar as it will be noted that a total of 1.71 gal. per sq.yd. was used in the top stabilized inch and in the surface treatment. This excess quantity of bituminous material apparently causes a softness which results in a slight deformation of the surface by traffic and causes cracking in the thin crust formed on top of the bituminous mat where it has cured and hardened.

No maintenance work has been necessary on the project during the first six months as the softness and cracking has not inconvenienced traffic and it is desired to see if the soft section will not become more stable as the bitumen cures.

The quantity of tar used was varied in an attempt to determine the minimum quantity that would waterproof soil of the character encountered. Apparently the smallest quantities used both in Part No. 1 and Part No. 2 were sufficient as the only section showing any distress at all is from Sta. 44 to Sta. 52+80 where the application was heaviest on Part. No. 2.

No particular difficulties were encountered in the construction; ordinary maintenance equipment was used and the operators had not had previous experience on this type of work. The cost of the work complete with wearing surface ran from 31c. to 39c. on Part No. 1 and from 35c. to 39c. on Part No. 2, varying with the quantity of material used.

While it is too soon to draw conclusions as to the durability of this work, it certainly indicates a possibility of developing a type of pavement that will be entirely satisfactory for a vast mileage of highways. It is also reasonable to believe that with mixing and compacting equipment designed especially for this type of work the cost can be reduced somewhat from the lower figures obtained on this project.

The writer wishes to express his appreciation for the cooperation and assistance rendered in this experiment by A. C. Havens and R. W. Parks of the Koppers Company.

Flat Slabs on 25-ft. Spans In Earthquake-Resistant School

by HAROLD B. HAMMILL
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Concrete floors, walls, roofs, and columns act as rigid frame units to resist earthquake force

GLEN PARK SCHOOL, one of San Francisco's more recent school buildings, is a two-story, reinforced concrete structure designed to utilize walls, floors, roof and interior columns as indeterminate frames for resisting earthquakes. The floor slab in the second story and the roof slab, both of 25-ft. span, are without beams, a design which has not been used extensively in schools. However, measurements have shown the net deflection at mid-span to be only 0.08 in., justifying selection of this type as a desirable and economical design.

The school is located in the south-central part of the city on a ridge of hard clay about 3¾ miles east of San Andreas earthquake fault. This location, judged by the relative amount of destruction in the 1906 earthquake, has foundation conditions that may be classed with the best in the city; seismic activity in this area is "weak." The long central portion of the building, Fig. 1, is two stories high and is devoted to classrooms. This central portion is to be flanked on one end by a one-story kindergarten (not yet built) and on the other end by a large auditorium and basement. The following comment on design refers primarily to the central portion of the structure where the height is two stories.

Designs for this building were made subsequent to the passage of state laws requiring all school buildings to meet established standards of resistance to horizontal forces such as are caused by earthquakes. These laws, as applied to the Glen Park School, required the structure to be able to carry a lateral load equal to 10 per cent of the weight of the building distributed in the same way as the building weight distribution. In applying this horizontal load it was permissible to figure a 33 1/3 per cent increase in usual working stresses.

In working out the design the objective was to meet requirements of classroom size and arrangement and to provide the necessary resistance to horizontal forces with minimum expense. These requirements have been met very satisfactorily by the design shown in the accompanying drawings.

The reinforced concrete construction used is commonly called the

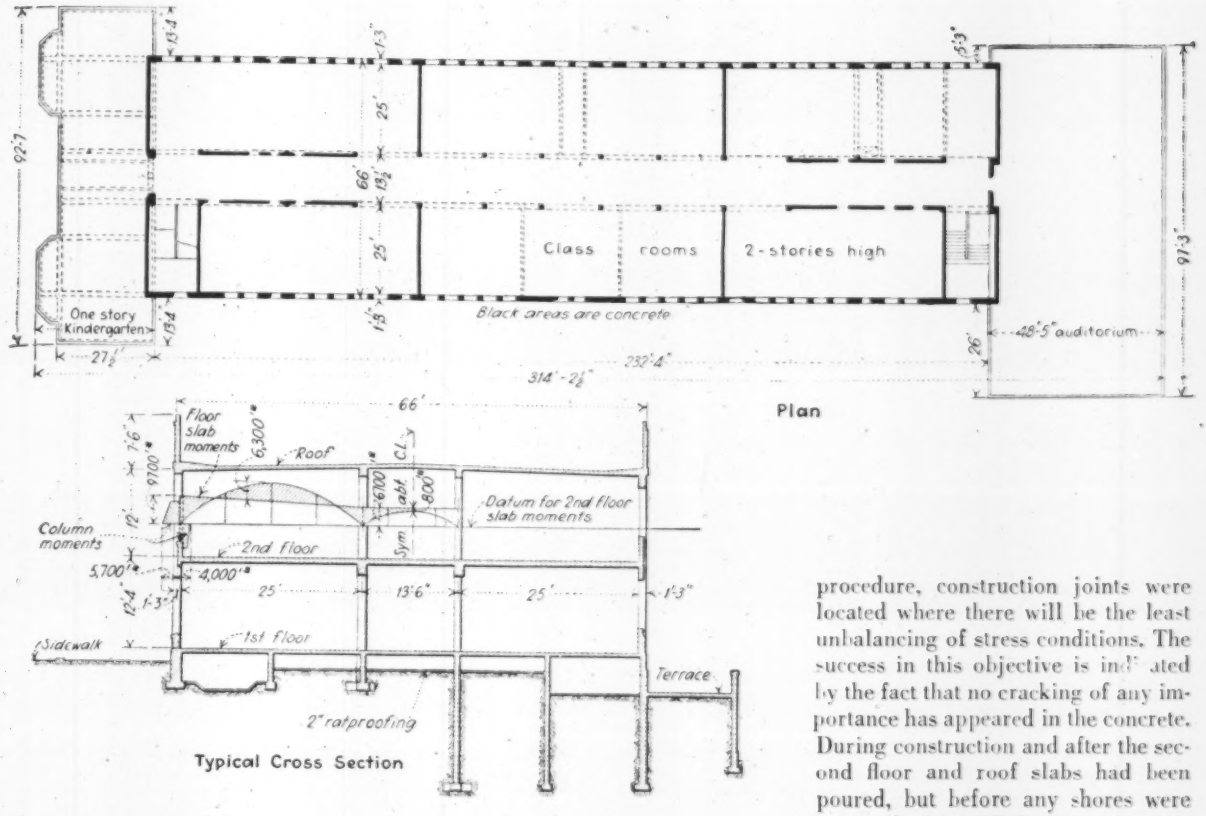

Fig. 1. Concrete school framing of flat slabs on exterior and partition walls designed to resist earthquakes. The moment diagrams for column and second floor slab under vertical loads are shown on the cross-section.

"rigid type." The only exception to all-concrete design is the roof over the auditorium. This is a 2-in. timber sheathing on structural steel trusses from which is suspended a metal lath and plaster ceiling.

In the classroom structure, floor and roof slabs were figured as horizontal diaphragms for transferring horizontal forces to the walls. All joints were designed accordingly. In addition to the exterior and connectings walls required for the interior arrangement, additional concrete walls were added on corridor partition lines for the sole purpose of resisting lateral loads. Exterior walls were designed as bearing walls with a uniform thickness of 15 in. which makes columns unnecessary. Where concrete walls are not used on corridor partition lines, second floor and roof loads are carried by concrete columns and longitudinal girders. There are no floorbeams in the 25-ft. span between exterior bearing walls and the corridor partitions.

The second floor slab is 8 in. thick and reinforcing on the bottom is ⅝-in. bars on 4½-in. centers. Bars ⅝ in. in diameter on 11-in. centers were used to reinforce the compression flange for its full length to reduce deflections. The roof slab is 7 in. thick with reinforcing similar to that in the second floor. Slabs thinner than 8 in. and 7 in. respectively would have been sufficient to carry the loads in these 25-ft. spans, but the dimensions used are required as the minimum permissible under the present law governing school building construction.

Architectural treatment

Architectural treatment of the exterior elevations was made such as to lend itself well to the design of the indeterminate frames. Although there are many windows, they were made narrow and were spaced so a structural column always came between openings. Thus it was possible to develop a large restraining moment in the exterior walls to resist negative slab moments.

In planning the concrete pouring procedure, construction joints were located where there will be the least unbalancing of stress conditions. The success in this objective is indicated by the fact that no cracking of any importance has appeared in the concrete. During construction and after the second floor and roof slabs had been poured, but before any shores were removed, Ames dial gages were installed at the center of several spans to determine the deflection of the second floor slab. With the dials set at zero the shores under the second floor were removed. The deflection of 0.12 in. recorded when these shores were removed included the effect of dead weight of the second floor slab plus whatever load was transmitted to it through the shores supporting the roof slab. Later, when the shores above the second floor supporting the roof slab were removed, the deflection of the second floor slab, as measured on the same gages, decreased to 0.03 in.—an entirely satisfactory answer to any question as to whether this design would result in objectionable deflection.

The contract for the central, two-story portion of the school was let as one unit for $190,000. The auditorium was a separate and later contract. Figuring classroom, corridor and stairway space in the two-story structure, the total cost amounted to $3.92 per sq. ft. of floor area.

Jno. B. Leonard was structural engineer in charge of the work, and detailed designs were made by the writer. Lewis P. Hobart and Bliss & Fairweather were the architects. J. McLaughlin was the contractor.

Notes on Sewage Disposal

A monthly summary of current developments conducted by Willem Rudolfs

BIOLOGICAL THEORIES—Studies of natural purification in rivers conducted by U. S. Public Health Service investigators have led to the conclusion that the principal role of protozoa in polluted water is to keep bacteria in check. Under these conditions the bacteria are stimulated to multiply more rapidly and are thereby more effective in purification.

On the basis of extensive studies Viehl (*Zeitschrift für Hygiene und Infektions Krankheiten*, 119, 383-412, 1937) believes that the role played by the bacteria and protozoa in natural and also artificial biological purification processes (such as activated sludge) is as follows: Oxidation of soluble materials is caused by bacteria; protozoa have no practical influence in this activity. But flocculation and adsorption of collids is a function associated with protozoa, especially the ciliates. These organisms regenerate sludge particles, restore adsorptive power and thereby speed up adsorption processes. When the protozoa are incapable of handling the process bacteria must take their place. However, because bacteria cannot take up the suspended material the same as ciliate protozoa, they must employ enzyme action. This requires time, and consequently colloids are removed at a slower rate than by adsorption. The absence of protozoa, therefore, usually results in a more turbid effluent from activated sludge plants and a slower clarification of polluted streams. This conception of the purification mechanism relegates physical and chemical factors to merely incidental phenomena. Keeping bacteria in check would be an integral function of the ciliate protozoa.

Results obtained by the Water Pollution Research Board of England (*Annual Report*, 1936) leads to the conclusion that the greater part, if not all, of the oxidation of sewage by air is dependent on the presence of certain enzymes in sewage or sludge. The most potent source of enzymic activity appears to be bacterial cells, partly because bacteria are usually so much more numerous than other micro-organisms such as protozoa and partly because enzymic activity of the bacterial cells appears to be greater than that of protozoa. It appears that many of the dead bacteria present in the sludge retain a fair degree of oxidizing activity and, because of their predominating numbers (from 100 to 1000 times more than live bacteria), play an important part in the oxidation of sewage. The continued activity of the sludge even when saturated with sewage suggests that some of the soluble constituents may be oxidized in solution and some after adsorption on the surface of the sludge.

MILK WASTE TREATMENT—For several years Kessner has been treating dairy waste from a plant at Hamoir (Belgium) by the surface aeration (brush) activated sludge process with good success. Results from an experimental compressed air activated sludge plant treating crude milk waste have now been made available by the Water Pollution Research Board of England (*Annual Report* 1936). With a crude liquor of about 800 p.p.m. B.O.D. diluted with effluent four times, and an aeration period of 24 hr. the results over a period of 4 months show an average B.O.D. in the effluent of only 25 p.p.m. The treated effluent did not contain fat, while analyses of the activated sludge showed 3 to 20 per cent fat content (on the dry sludge basis). Laboratory experiments have shown that whey washings can also be purified by the activated sludge process.

Biological investigations showed that the number of spore-forming bacteria in the activated sludge was always small in relation to the total number of viable bacteria. Spore-forming organisms were invariably strongly proteolytic, peptizing milk and liquifying gelatine. A considerable number of yeasts were found, which possibly thrive on the products of decomposition of milk by bacteria.

BEET SUGAR WASTE—Methods of beet sugar waste treatment involving settling, chemical precipitation, and the re-use of sludge and clarified liquid were developed some 25 years ago by Kessener in Holland. Since then a search for improved methods, less costly and easier to operate, has been going on. Factory experiments reported by Eldridge and Theroux (Mich. Eng'g Exp. Sta. *Bull.* 71) dealing with settling, chemical treatment and vacuum filtration of beet sugar waste are not very encouraging. It appears that the sludge produced in any case must be conditioned with lime if high rates of vacuum filtration are to be obtained. From 50 to 80 lb. of lime per 1000 gal. of factory waste sludge, and from 20 to 50 lb. for the Steffens process waste mixtures were required. Conditioned sludge could be filtered at the rate of about 4.5 gal. per sq.ft. per hr.

Using plain sedimentation the suspended solids removal was about 95 per cent, B.O.D. reduction 50 per cent. The chemical coagulation process produced a slightly greater B.O.D. reduction but not sufficient to justify the additional cost for lime required. A heavy sludge with 80 to 85 per cent moisture was obtained. The sludge volume averaged about 7000 gal. per million gallons of waste.

REAERATION OF SLUDGE—Experience with activated sludge has shown that if the sludge is overworked it becomes much less effective as a purifying agent. Experiments in the laboratory seem to support the view that this is mainly due to a supersaturation of the sludge with certain constituents in sewage, and that when this condition exists the addition of a further quantity of sewage cannot lead to any increased activity. Heukelekian (*Sewage Works Jour.* 8, 214, 1935) stated that a good working activated sludge can consistently take care of a definite quantity of raw suspended solids; an excess of sewage, however, is not readily oxidized. Experiments by the Water Pollution Research Board of England (*Annual Report* 1936) show that sludge saturated with sewage will not oxidize further

additions of sewage until the concentration of substrate in the saturated sludge has first been considerably reduced by a period of aeration. The saturated sludge, however, has a much greater rate of adsorption of oxygen than the initial sludge from which it is prepared. These and other experiments on saturated sludges point conclusively to the value of periodic reaeration of sludge, especially when the ratio of sludge to sewage is too low, or the sewage contains an excessive amount of oxidizable matter.

PLANT CONTROL—The flash of an electric lamp in the local telephone exchange serves as a signal that pumps in the automatic sewage pumping station at Meadville, Pa., are faced by a storm flow exceeding their capacity, according to an item in the American Public Works Association *News-Letter*. Float switches in the suction well complete the signal lamp circuit if the level of the water in the well rises above the critical point. When the light goes on the chief telephone operator calls up a designated city official, who thereupon goes to the pumping station and opens a by-pass line that discharges directly into a nearby creek. If the official called does not answer, the telephone operator calls in succession the names on a list she has of public works department employees. The signal lamp also lights if for any reason the level of water in the suction well of the station falls too low.

SEDIMENTATION TESTS — Large scale experiments to determine the effect of sedimentation and grease skimming on a sewage flow of 60 m.g.d. were conducted at Boston over a period of 28 days during 1936 (*Report* Comm. Investigating Discharge of Sewage in Boston Harbor, House; No. 1600, 1936). A trapezoidal storage tank 162 by 612 ft., varying in depth from 8 to 11 ft., was used with and without skimming equipment; the average detention period was 2.8 hr. Results showed that with the comparatively weak Boston sewage (suspended solids 119 and B.O.D. 144 p.p.m.) a 56.7 per cent removal of suspended solids and 25.6 per cent reduction of B.O.D. took place. It was estimated that as much as 40 cu.ft. of floating material per million gallons of sewage was held back by the skimmers. Analyses of the floating material which consisted of grease, garbage and possibly some sludge, indicated 89 per cent moisture and 77.5 per cent volatile matter; 42 per cent of the dry solids was fat.

FORCED DRAFT IN SEWERS—In order to arrest disintegration of a concrete trunk sewer caused by hydrogen sulphide corrosion, artificial ventilation is being employed with great success in Brisbane, Australia, according to the 1935-36 annual report of the sewage department in that city. Large electric fans (one of 20,000 and the other of 15,000 c.f.m. capacity) have been installed at the far end and at the center of the sewer, and these force air through the conduit which is provided with a number of openings to permit the gases to escape. The forced draft dries out the disintegrated concrete and this permits easy removal of the loose sand and gravel; repairs are then made applying aluminous cement mortar with a pneumatic gun.

In addition to arresting the corrosion of concrete, the following benefits are claimed to be obtained from the use of artificial ventilation: (1) Increased discharge capacity given to the sewer owing to the velocity of flow being increased from 2.25 to 2.75 sec. ft. due to the air current of 23 m.p.h. passing over the surface; (2) ending of a nuisance in the district caused by sewer gas odor; (3) improved working conditions for men engaged on maintenance cleansing of the sewers; (4) reduction in cost of maintenance of all iron and steel work in pumping chambers and sewer manholes previously affected by hydrogen sulphide gas.

BACTERIA IN SEAWATER — In studies made on quahogs in sewage-polluted seawater it was found (*Report* Special Comm. Investigating Discharge of Sewage in Boston Harbor, House; 1600, Dec. 1936) that in 48 hrs. practically all the *coli-aerogenes* organisms had disappeared from the seawater and none was found in the quahogs. To determine if this disappearance was due to seawater or to the combined action of both the water and quahogs, seawater to which domestic sewage had been added was tested alone. Analyses showed that there was an immediate reduction of the number of bacteria in the water. The results indicate that on discharging sewage into saltwater a reduction of about 33 per cent bacteria may be expected in 15 minutes and about 50 per cent in one hour. Depending upon the sewage concentration, from 80 to 95 per cent disappeared in 48 hours and 99.9 per cent in 96 hours. These results are in accord with findings abroad where relatively large volumes of sewage are discharged into the sea and effectively distributed.

DIGESTION TANKS — For many years the value of deep versus shallow digestion tanks has been debated from the standpoint of sludge density. With the advent of gas collection other factors have been emphasized as more important. Sperry (*Annual Report*, Aurora, Ill., San. Dis., 1936) states that the density in the digestion tank and consequently the volume of sludge varies with the method of operation. He found that when sludge was added to the tanks 42 per cent of the total gas was produced the same day; with the digestor resting one day between charges 35.2 per cent was obtained; and with a two-day rest period 22.5 per cent of the gas was produced. Comparing the period of operation when the sludge was distributed each day with periods when the tanks received sludge only every second or third day, it was found that the release of gas per square foot of the tank area was greater and the sludge thinner when the tanks were charged daily; gas production per ton of dry solids, of course, remained the same.

It was concluded that there is a definite relation between the rate of gas released and the working capacity of a digestor, and that the tank should have more width than depth to provide the proper area for gas release. The practice of computing cubic feet per capita capacity of a digestor based upon the whole volume available was held to be unsound.

It has previously been shown (*Sewage Works Journal* 3, 64, 1931) that sludge concentration is a function of initial sludge density in time of storage, and that concentration is also effected by gasification. Therefore, the conclusions drawn from the plant experiences at Aurora, i.e., that surface area in a digestor is important, seems well-founded, and should be taken into consideration by designers of tanks.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Cleaning Concrete Surfaces To Ensure Bond

by DANIEL MCFARLAND

Mason City, Wash.

Large blocks of concrete built in successive lifts at Grand Coulee dam required such large areas of surface to be cleaned for adding fresh concrete that many cleaning devices were tried. Some that have been successful are:

WATER-AIR JETS — All concrete is required to set 72 hr. before new concrete is added, sprinkling being nearly constant during the curing period. As soon as the concrete has set enough to stand it, the surface is cut with a jet of water and air. This takes off all the particles that are not firmly a part of the concrete. The usual jet is a simple Y-shape nozzle with connections for air hose and water hose. To cover a wider area a head consisting of a piece of 1½-in. pipe with fifty-five $\frac{3}{16}$-in. holes in a length of 18 in. is used. It has ¾-in. pipe connections that convey the air and water and also serve as handles. The equipment is mounted on rubber-tired wheels so that the operator can push or pull it over the concrete easily. At first the air and water entered one end only but this caused separation since the water went to the far end and the air came out the near end; when the air was brought to both ends the jet worked uniformly.

REMOVING WHITE STAIN — The water jet washes out a small amount of soluble material from the cement and leaves a white deposit on the surface of the concrete. A thorough washing with an air and water jet and brushing usually gets rid of the thin white deposit but sometimes, and especially if the time between pours is more than three days, sand blasting is resorted to. It was found by covering the concrete with sand after cutting that the cleaning work could be reduced and that most of the white material leached out onto the sand instead of depositing on the surface of the concrete. This was not a complete solution because of the expense of placing and removing the sand and also the interference with the concrete work when the cranes were moving the sand.

JETTING WITH POWER BRUSH — The next experiment and one that is now being worked out is the use of a power-driven brush for cleaning the surface. A circular brush with steel wire bristles is put on an electric-driven floor sander. It worked fairly well and then an air motor was put in place of the electric motor. The reasons for the change are that the air lines are in and are needed for the air and water jets, the weight is less, and there is less danger to the men than from handling electric wires on the wet concrete. The brush is also equipped with a water connection so that the surface being cleaned will be washed free of the cuttings. The whole is equipped with a handle so that the operator can push it around as required. The apparatus is light enough so that one man can carry it from place to place.

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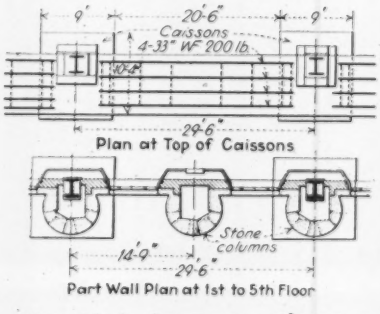
Ornamental Facia Columns Carried on Girders

Facia columns coming between structural columns are carried on girders spanning between structural



Supports for heavy stone columns.

column foundations of the new federal court and custom house at St. Louis, Mo. The accompanying drawing shows the arrangement. The columns are hollow limestone 7 ft. in diameter and 60 ft. high. Placed on 14¾-ft. centers, there are 36 of these columns, each weighing from 625,000 to 650,000 lb., which had to be supported independently of the steel frame of the building whose wall columns are on 29½-ft. centers.

Stone columns occur at every steel column and at the mid-point between the steel columns. Caissons sunk to rock at the steel column locations were made large enough to accommodate the stone columns. Groups of 33-in. rolled girders were then set to span between the caissons and pick up a pier at their midpoints on which the alternate stone column was supported.

The architects for the building were Mauran, Russell & Crowell, and the structural engineers Taxis & Becker, both of St. Louis, Mo.

$3 to $5
paid on acceptance for items suitable for the pages of From Field and Office.

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A Better Crown Formula For Roads

by FRANK CNARE

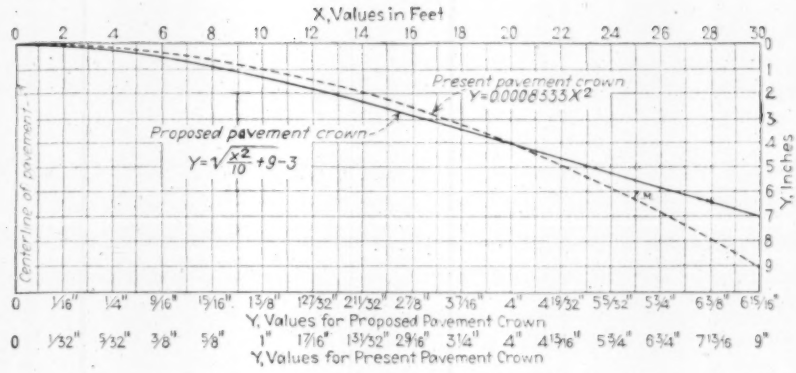
Design Engineer, State Highway Commission of Wisconsin, Madison, Wis.

For several years the standard details of the Wisconsin highway commission have provided that the transverse section of portland cement concrete pavement be shaped in accordance with the parabolic curve formula:

$$Y = \frac{X^2}{100}$$

where Y is the crown in inches at any given point and X the distance measured in feet from the centerline to the point in question.

This formula produces a curve which is rather flat at the apex of the parabola, or the centerline of the pavement, with gradually increasing slopes as the edges of the pavement are approached. When extended it produces a crown of 1, 4, 9, and 16 in. at distances of 10, 20, 30, and 40 ft., respectively, from the centerline. The 1 in. crown at 10 ft. is probably satisfactory, but when applied to wider pavements the formula produces too-much crown, as the slopes near curb and gutter become too steep. Reducing the values of Y and increasing the values of X produces too flat a crown at or near the centerline. To overcome this objection the



Pavement crowns produced by the usual parabolic formula and the new formula adopted for Wisconsin concrete roads.

new formula was developed which is expressed as follows:

$$Y = \sqrt{\frac{X^2}{10} + 9} - 3$$

This formula produces crowns of 1⅜, 4, 7, and 10 in. at 10, 20, 30, and 40 ft., respectively, from the centerline. It will be noted from the accompanying graph that it has more slope at the first 10 ft., the same crown at 20 ft., and less in the succeeding 10-ft. intervals. This crown has been adopted as standard on Wisconsin concrete pavement construction.

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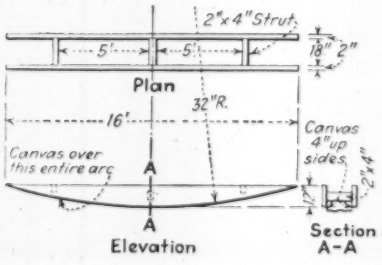
Invert Concrete Ponded By Portable Dams

Ponding has been used extensively to cure the invert on parts of the Colorado River aqueduct (Los Angeles water supply) that are in desert sec-



Portable dam for ponding invert.

tions. At about 2,000-ft. intervals, where manholes are located, invert dams made of canvas stretched onto a wood frame are placed. These dams form a succession of pools that keep the concrete flooded. As shown by the drawing two segmental sideboards held parallel by cross-braces are covered with canvas on the arc bottom. The canvas is wide enough to extend 4 in. up inside the sideboards to which it is tacked and cleated and also is 4 in. wider than the space between sideboards so that it bags down and makes a close fit when weighted down with the earth with which it is filled. The canvas-covered frame can be handled by two men; when removed no earth or debris is left to be cleaned out of the aqueduct.

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Photoelectric Cells Control Drawbridge Closing

Centering of the swing span of the Kincardine-Forth bridge in Scotland ready for the locking bolts to be thrust home is indicated by photoelectric cells. As described by John Guthrie Brown before the Institution of Civil Engineers, the accurate centering of the bridge in the road-position preparatory to driving the locking-bolts is provided in the form of a photoelectric indicator and visual indicators.

The photoelectric system, consists of a box 5 ft. long fastened to the end cross-girder at one end only of the swing-span. It contains three photoelectric cells, the end ones near the base and the center one near the top of the box. Funnels with white interiors guide the light through a mask which occupies the front of the box. In front of this again is a hinged lid with glass windows.

When a beam of light impinges on the photoelectric cell, the cell instantaneously operates a small relay due to the altered resistance, and this, amplified by a suitable valve of the wireless type, operates another relay. On each end pier, boxes are built into the concrete which contain three groups of three 60-watt lamps at the bottom and one lamp near the top at the center. Steel masks concentrate the light and permit adjustment to be made. On the control-desk three lamps colored red, amber and green, are installed. As the bridge swings towards the closing position the side lamp lights first, then the center lamp lights and then the other side lamp lights if the bridge is still swinging. In addition, a bell rings for the further guidance of the operator as each lamp lights.

The spacing of the lamps is so arranged that if a side and center lamp or the center lamp only is lit, the bridge is sufficiently centered to permit the bolts to be driven; if a side lamp only is showing, the bridge is not properly centered and so must be inched into position until the center light is showing. The photoelectric cell which is of the caesium type is not subject to any deterioration and has an indefinite length of life. The ordinary amplifying valve has a useful life of several thousand working hours, while the lamps, which are operated below their normal voltage, have also a very extended life.

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Brief Memoranda

FABRIC-LINED FORMS give an unusual and pleasing surface to concrete portals and pilasters of the new bridge across the Firth of Forth at Kincardine, Scotland. After various trials selection was made of a wide-mesh hessian canvas such as in used for backing rugs. This was guled to the forms; the glue found to be most resistant to the action of wet concrete was a cold-water casein glue. Form lining and concrete placing required considerable care. — JOHN GUTHRIE BROWN, *Proceedings*, Institution of Civil Engineers, Session 1936-7.

STEEL H-PILES used in building the steel pier at Puerto Armuelles, Panama, for the United Fruit Co. were given greater value as displacement piles in soft material by timbers bolted to the web or to the flanges or to both. Steel brackets bolted or welded to the steel pile provided shoulders against which the tops of the timbers had bearing. In all 192 H-piles were lagged in this manner. The maximum area provided was 12 x 27 in.—E. L. DURKEE and R. L. MCINTOSH, *Journal*, Boston Society of Civil Engineers, April, 1937.

THE WEEK'S EVENTS

Continued from page 895

New York Bay Tunnel Found Uneconomical

The proposed railroad freight tunnel under New York Bay from Jersey City, N. J., to Bay Ridge, Brooklyn, would cost more than the savings from the present car float interchange would warrant, according to the report of the Port of New York Authority. The report estimates the cost of a single track tunnel, including approaches, necessary changes in supporting yards and the purchase of 13 electric locomotives, at $57,000,000. The net saving in operation by way of the tunnel, as compared to the present carfloat interchange, is $1.61 per car, plus intangibles which cannot be evaluated in dollars and cents. On the basis of the 1935 level of traffic, 670,448 cars, the operating saving, as compared to the float route, would amount to about $1,000,000 per annum, which would be inadequate to support the investment required for construction of the tunnel and its connections.

The project, known as the Cross Bay Union Freight Tunnel, has been a part of the bi-State port plan since 1922. Assisting Commissioner Rudolph Reimer, chairman of the Port Authority's special committee, in making a study of the proposed tunnel were representatives of the Pennsylvania, New Haven, Lehigh Valley and Central of New Jersey railroads. Commissioner Reimer announced that the record of the public hearing upon which the report was based would be held open until June 30 for the purpose of receiving additional statements or data from any interested parties.

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Hotel Concession Granted at Boulder Dam

Secretary of the Interior Ickes has granted a contract to a concessionaire company to build hotels, cabins and chalets for tourists and provide them with train, auto, boat and horse transportation in the region surrounding Boulder Dam and Lake Mead. All concessions will be operated under supervision of the National Park Service, which must approve construction of buildings and facilities and the prices charged. All profits over 6 per cent must be divided with the Government, which also receives an annual fee from the company.

The contract does not give the company exclusive hotel rights or exclusive automobile transportation rights on business originating outside the recreational area, but merely gives the company equal rights with other bidders on future developments.

PERSONAL

E. J. HENEN has been appointed city engineer of Great Falls, Mont., succeeding ARTHUR J. COOK.

FRANK M. O'DONNELL, construction engineer of Woonsocket, R. I., has been appointed engineer in the Rhode Island Parks Division by Gov. R. E. Quinn.

F. W. DANIELS, connected with the H. K. Ferguson Co., building contractors, Cleveland, Ohio, since 1924, has been named chief engineer of the company. He has been responsible for the construction of many large industrial plants in this country and in Japan.

THEODORE M. KUSS, chief inspector for the Golden Gate Bridge and Highway District on the construction of Golden Gate Bridge, is now connected with the Pacific Bridge Co., of San Francisco, as resident engineer on the construction of a wharf and road for the navy ammunition depot at Balboa, C. Z.

DEAN R. L. SACKETT, for long head of the School of Engineering at Penn State College, has resigned that position. He has been named Dean Emeritus of the College. Dean Sackett will devote his time in the near future to the interests of the E.C.P.D., particularly on the Committee on the Selection and Guidance of Engineering Students.

WESLEY W. HORNER, for 28 years associated with the St. Louis Board of Public Service as engineer of streets and sewers, and for the past four years engaged in private consulting practice, has been appointed Professor of Munipal and Sanitary Engineering in the Civil Engineering Department at Washington University, St. Louis.

HARRY W. EUSTANCE, connected with the city engineering department of Ithaca, N. Y., since 1924, has resigned as city engineer and will join the Portland Cement Association to specialize in cement soil stabilization. He is responsible for many major municipal improvements at Ithaca, including the airport, modernization of the sewerage system, golf course, Lake Front Park and a recreation area at the head of Lake Cayuga.

Central Valley Progress Outlined by Young

Surveys and plans have been completed on the Central Valley reclamation project in California to the extent that construction contracts could be awarded exceeding, in the aggregate, the total fund available at present, according to a summary made by Walker R. Young, in charge of the project for the Bureau of Reclamation. Surveys have been completed on Kennett Dam, Table Mountain Dam, Baird Dam (abandoned in favor of Kennett site), and the Friant Dam. The government camp sites at Kennett and Friant have been selected, and at the latter site contracts have been awarded for streets, sewers, waterworks, cottages, dormitories and other buildings.

Plans and specifications covering grading of the first 15 miles of the 30-mile relocation of the Southern Pacific R.R. around Kennett reservoir are now in preparation. Preliminary designs, surveys and explorations for foundations of the combined railroad and highway bridge across Pit River have been completed. Field surveys for the first 13 miles of highway relocation at Kennett reservoir have been made.

Final locations of the Madera and Friant-Kern and Contra Costa canals have been made.

CALENDAR OF MEETINGS

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS, annual meeting, Urbana, Ill., June 21-24.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer convention, Milwaukee, Wisc., June 21-25.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, annual meeting, Cambridge, Mass., June 28-July 2.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, New York City, June 28-July 2.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention, Detroit, Mich., July 21-24.

PENNSYLVANIA SEWAGE WORKS ASSOCIATION, annual conference, State College, Pa., June 21-23.

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License Examinations

MICHIGAN: Examinations for architects at the University of Detroit and examinations for engineers and surveyors at the University of Detroit, the Michigan State College, the Michigan College of Mines, and at Ironwood, June 21-23. Information may be obtained from the Michigan State Board of Examiners, 306 Transportation Building, Detroit.

OBITUARY

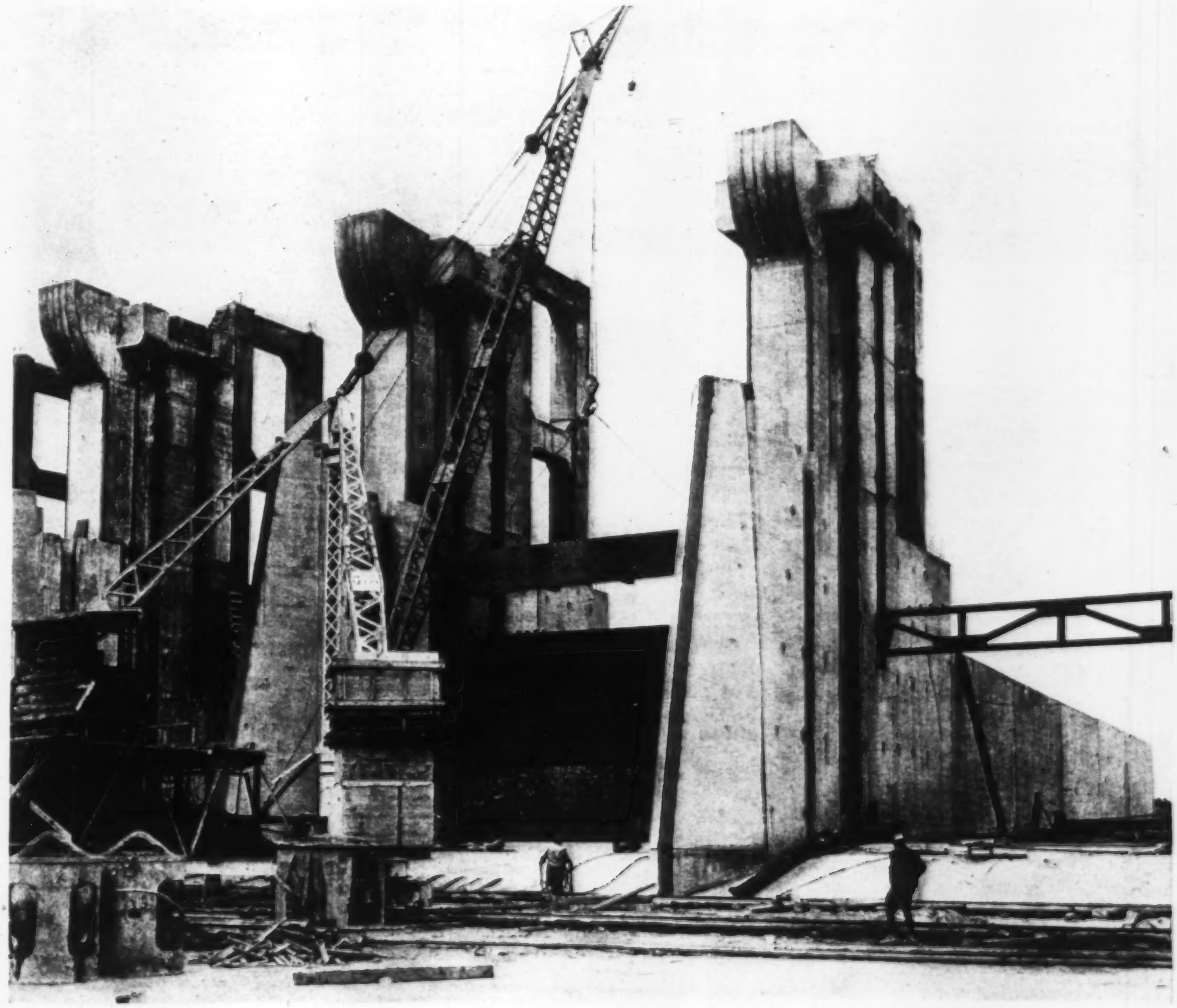
JOHN E. CARNEY, pioneer building contractor of Seattle, Wash., died in that city on June 2.

PIERRE EDMOND AMIOT, prominent Canadian engineer, died at his home in Montreal, June 1, at the age of 71. For 33 years he was with the Federal Department of Public Works as Chief District Engineer at Rimouski and Chicoutimi.

GEORGE C. ANDREWS, former water commissioner of Buffalo, N. Y., died in that city May 30 at the age of 54. He was a graduate of Lafayette College, and for some time was connected with the construction of the New York Barge Canal as resident engineer. He built the waterworks filter plant at Buffalo and the locks and dams at Fulton and Lockport, N. Y.

JAMES J. BLAKE, formerly chief engineer of the Queens County Highway Department, New York, died recently at his home in Elmhurst, L. I. Mr. Blake came to Queens in 1894; took charge of construction for the New York & Queens Ry. Co. He was connected with much of the early subway construction work in Manhattan and had also been a supervising engineer with the New York State Board of Water Supply.

DR. PHILIP B. WOODWORTH of Glen Ellyn, Ill., former dean of the Engineering School of Lewis Institute, and for two years president of Rose Polytechnic Institute at Terre Haute, Ind., died at Elmhurst, Ill., on June 7 at the age of 71. Dr. Woodworth, a native of Auburn, N. Y., graduated from Michigan State College in 1886. He taught at his Alma Mater from 1892 to 1899 and then became associated with Lewis Institute, retiring as Dean of the Engineering School in 1917.



GUARDIANS OF FORT PECK DAM SPILLWAY WAITING FOR A FLOOD THAT MAY NEVER COME

MASSIVE PIERS shouldering 50 x 25 ft. stoney gates will guard the entrance of the 2-mile spillway at Fort Peck reservoir. Some engineers believe that this magnificent structure will never get wet except from eastern Montana's sparse rainfall, but in the event the huge lake should ever rise to spillway level, it will be possible to control the elevation of the lake within a range of 25 ft. Waters passing these gates will slip through a mile of concrete lined channel and then must pass through another mile of shale cut before entering the Missouri River far below the dam. At the far end of the lined section a concrete cutoff wall of cellular type is being sunk 130 ft. deep under the shale. The above view shows a traveling stiffleg derrick assembling one of the 75 ton gates. One of the sixteen gate sections is being placed.

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

SEA WATER INTAKE FOR WATER SOFTENING PLANT, SOUTH CAROLINA

OWNER— Board of Township Commissioners, Sullivan's Island, Charleston County. John McCrady, engineer, Charleston, S. C.

PROJECT: Installation of zeolite softeners, using (a) sea water for regeneration; (b) lime softeners; installation of sea water intake.

BIDS: Four proposals were opened May 19, 1937, ranging from the low of $15,092 to a high of $17,396 for the complete work.

CONDITIONS: The site of the work is accessible by water and highway. Completion is scheduled for 60 days after contract award with minimum hourly wages stipulated at 75 c. for skilled, 35 c. for semi-skilled, and 25 c. for common labor.

MATERIALS FURNISHED: Contractor furnishes all materials required.

LOW BIDDERS:

1. J. B. McCrary Co., Atlanta, Ga. $15,092
2. Wannamaker & Wells, Inc., Orangeburg, S. C. 16,235
3. A. H. Guion & Co., Charlotte, N. C. 17,396
4. J. B. McCrary Co. (alternative for lime softener) 13,022

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Sea water intake equip't	total	$3,200.00	$5,000.00	$4,800.00
2. C. I. pipe, 6 in.	270 l. f.	1.20	1.50	1.30
3. C. I. pipe, 3 in.	2,450 l.f.	.62	.90	.75
4. C. I. pipe, 2 in.	1,000 l.f.	.39	.60	.55
5. Valves, 2 in, with boxes	2 each	18.00	20.00	17.00
6. Valves, 2 in, with boxes	2 each	11.50	15.00	12.00
7. Water softening equip't	total	9,600.00	8,200.00	9,800.00

SIPHON PIPE CROSSING, ALL-AMERICAN CANAL, CALIFORNIA

OWNER: Bureau of Reclamation, Dept. of Interior.

PROJECT: Construction of two parallel steel pipe siphons, each 374 ft. long and 15.5 ft. in diameter, over the New River crossing of the All-American Canal near Calexico, Cal. Each of the two pipes will be fabricated in five units of 72 ft. lengths, with four end units of 7 ft. lengths. The appurtenant construction work includes the inlet and outlet structures, the four intermediate piers to carry the siphon, setting the pipe units and construction of canal bridges.

BIDS: Nine bids were opened in Yuma, Ariz. on May 7, 1937. Three of these were for the complete work as required by Schedules 1 and 2; the remaining six were confined to Schedule 1 (all work exclusive of the steel pipe). In addition, five other bids were received for the steel pipe work only. The nine bids on Schedule 1 ranged from a low of $269,721 to a high of $399,713; the pipe bids as required by Schedule 2, from $109,737 to $156,595, including shipping costs.

CONDITIONS: The Government shipping point is Calexico, Cal. with all materials it furnishes to be hauled to the site by the contractors. Completion of the combined work is scheduled for 600 days with minimum hourly wages stipulated at $1.12½ for skilled and 45 c. for common labor.

MATERIALS FURNISHED: The Government furnishes f. o. b. Calexico, Cal. all cement and concrete materials, reinforcing, steel and wood piling, drain pipes and fittings; four end units of the pipe siphon to be installed by the concrete contractor; rubber water stops, rubber and cork fillers; all operating mechanisms; structural steel for highway bridge; lumber other than form and temporary construction; metal flume sheets, bituminous materials; miscellaneous metal work; electrical conduit, fittings, control cabinet; paint materials.

LOW BIDDERS: (Schedule 1)

1. Sharp & Fellows Contracting Co., Los Angeles, Cal. $269,721
2. Gates & Huntley, Los Angeles, Cal. 299,232
3. Atlas Const. Co. & C. F. Robbins, Pasadena, Cal. 323,133

(Schedule 2)

1a. Southwest Welding & Mfg. Co., Alhambra, Cal. 109,737
2a. Pittsburgh Des Moines Steel Co., Des Moines, Ia. 115,000
3a. Western Pipe & Steel Co., Los Angles, Cal. 124,635

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excavation, structural	35,800 c. y.	$0.31	$0.25	$0.95
2. Excavation, backfill, piers	1,800 c. y.	3.25	7.00	1.25
3. Excavation, drainage ditches	4,700 c. y.	.22	.20	.50
4. Excavation, operating road	9,000 c. y.	.22	.30	.60
5. Excavation, river channel	8,000 c. y.	.33	.30	.65
6. Excav., temp, sect. drains	15,700 c. y.	.17	.20	.50
7. Excav., strip fdt. comp. banks	18,000 c. y.	.14	.20	.40
8. Overhaul sta. yd	10,000 c. y.	.015	.05	.015
9. Compacted embankments	144,000 c. y.	.245	.29	.55
10. Gravel, ext. slope, comp. bank	7,000 c. y.	1.85	2.50	2.00
11. Sand blankets under gravel	75 c. y.	1.90	3.00	2.00
12. Gravel blankets under concrete	3,000 c. y.	3.15	2.50	2.00
13. Gravel fills in concrete walls	300 c. y.	1.80	2.00	2.00
14. Backfill	25,400 c. y.	.17	.15	.25
15. Puddling, tamping backfill	1,800 c. y.	.60	1.00	.25
16. Concrete, structures	3,117 c. y.	14.15	18.00	11.00
17. Concrete in piers	1,720 c. y.	10.25	10.00	10.00
18. Concrete in canal lining	2,680 c. y.	9.30	8.00	7.00
19. Placing reinforcement bars	930,000 lb.	.0125	.016	.013
20. Installing rubber water stops	1,330 l. f.	.40	.60	.10
21. Install elastic joint filler	538 s. f.	.40	.50	.20
22. Precast-concrete crib members	202 c. y.	22.00	20.00	15.00
23. Dry-dock paving	150 s. y.	5.50	4.00	3.00
24. Riprap	487 c. y.	4.10	5.00	2.50
25. Drive steel sheet piling	181,940 lb.	.0125	.025	.015
26. Drive timber piles	3,180 l. f.	.62	.60	.45
27. Concrete piles, 30 ft.	12 each	69.00	55.00	50.00
28. Concrete piles, 40 ft.	255 each	92.00	71.00	80.00
29. Concrete piles, 45 ft.	306 each	103.50	80.00	85.00
30. Sewer pipe, uncemented joints, 6 in.	154 l. f.	.50	1.00	1.00
31. Cast-iron pipe drains, 6 in.	990 l. f.	.35	.70	1.00
32. Erect timber in structures	203 M.b.m.	26.00	75.00	35.00
33. Bituminous surface on bridge floors	440 s. y.	.65	1.00	2.00
34. Steel pipe, end units	38,000 lb.	.02	.03	.02
35. Bridge steel	81,600 lb.	.02	.02	.015
36. Install gates	40,700 lb.	.03	.05	.025
37. Install radial-gate mechanisms	15,640 lb.	.06	.05	.025
38. Install pipe handrails	3,200 lb.	.07	.06	.05
39. Erect metal flume No. 60	39 l. f.	1.50	5.00	5.00
40. Install steel pipe, 22 in. diam.	8,300 lb.	.02	.03	.02
41. Install misc. metalwork	5,000 lb.	.08	.10	.08
42. Install electric conduits to 14 in.	400 l. f.	.20	1.00	.15
43. Install electrical conductors	100 lb.	.50	1.00	.25
44. Welded plate steel pipe, 15.5 ft. (758 l. f.) inc. freight charges	540–85 ton	(1a) 187.58	(2a) 212.98	(3a) 216.75
45. Do. on U. S. B. L.	540–85 ton	187.58	196.29	214.27

(*Additional Contract Unit Prices on second following page*)